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THE DIVERSIFICATION OF THE SUGAR-CANE INDUSTRY*

Background paper for Issue I

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* The views expressed by the author in this paper do not necessarily reflect the views of the UNIDO Secretariat. This document has been translated from an unedited original.

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A. INTRODUCTION

World-wide, the cane sugar industry is faced with a crisis of growing proportions which has had serious effects on the developing countries that produce and export sugar. The crisis, caused by low price levels over long periods, accompanied by rising costs of production, has acted as a disincentive for the proper development of the sector, making the industry work with negative profitability or at most break even. The result of low prices and high costs has been decapitalization, and of course investment and/or reinvestment for modernization and even maintenance of the industry has been made difficult, inevitably leading to the obsolescence and inefficiency of factories and low productivity in the cane sugar agro-industry.

However, it is a fact that activity related to the sugar-cane sector has long been important in many of these countries. In some of them, it is considered to be the most important agro-industry, since various key aspects of the economy depend on it, such as employment and the generation of foreign exchange earnings from export, or savings in foreign exchange by import substitution for particular goods.

In view of the present critical economic situation of the sugar producing and exporting countries, most of which have the additional burden of an onerous external debt and many domestic socio-economic problems, it is necessary to look for alternatives that will help to provide effective solutions in the short, medium and long term, and, where possible, immediately; the object is to alleviate the typical effects of the crisis such as inflation, devaluation of national currencies vis-à-vis the strong currencies of the developed countries, unemployment, and supply shortages in domestic markets. Such effects occur because it is impossible to maintain acceptable levels either in the domestic production of goods and services or in the imports that are necessary to ensure that the life of the nation proceeds normally and that a certain socio-economic status is maintained. As far as possible, consequences must be avoided that generally occur in the political and social sector and are equivalent to regression or stagnation at the national level, in the worst of cases, and to the slow development of these countries at best.

The System of Consultations is the instrument by means of which the United Nations Industrial Development Organization (UNIDO) constitutes itself as a forum of the developed and developing countries for the purpose of contributing to the industrialization of the latter and thus to increasing their share of

world industrial production by creating new industrial capacity, and thus helping to establish a New International Economic Order. For all of the above reasons, we are analysing an agro-industrial sector in Latin America, the Caribbean, Asia and the Pacific, whose problems have economic, social, political technical and financial implications and must be addressed through the necessary North-South and South-South co-operation, as a means of finding, by joint effort viable alternatives and appropriate solutions for the situation of this agro-industry in these countries in particular and in the regions in general.

B. THE CANE SUGAR INDUSTRY

1. Background and present situation

The cultivation of sugar-cane and its processing for the production of foodstuffs, or, to be more precise, of sugar and molasses, dates from the times when travellers and sailors from rich and powerful countries occupied overseas territories in search of greater wealth. With the advent of sugar-cane, probably brought from the southern part of Europe [1/] to the newly occupied territories, the so-called plantation economies began and slaves hired from the locality or brought from other countries worked the soil and operated by hand rudimentary mills to extract cane-juice and then make sugar, a product that was of high value at that time.

The industrial revolution and the development of the metropolitan countries brought in their train technological innovation in the processing of sugar-cane and in the production of sugar in the colonies; this activity continued as an important part of many of these economies even after the countries had gained their political independence.

At present, the sugar industry throughout the world has for a long time been suffering from acute problems.

The following are among the principal important characteristics of the present world situation with regard to sugar:

1/ Recent information indicates that sugar-cane originated in the South Pacific some 8,000 years ago. The first record we have of it dates from 325 B.C., when it was mentioned by an officer of Alexander the Great's army in India. It then spread to China and later, in about the eleventh century A.D., reached Europe. In 1300, Venice was the sugar capital of the world.

Spain, which cultivated sugar-cane in the Canaries, sent it to America via the Island of Hispaniola (now the Dominican Republic) when Christopher Columbus made his second voyage to the New World in 1493.

The colonization of the Island of Madeira by the Portuguese in the fifteenth century contributed towards the spread of sugar-cane; later, Portuguese enterprises brought it to the west coast of Africa and then to Brazil.

In the Middle Ages, sugar was considered to be a luxury and was used only by the nobility. It was believed to have miraculous curative powers. By the middle of the sixteenth century it was already much prized by the pirates and was one of the most valuable products of the Island of Hispaniola and the New World.

(a) Large accumulated surpluses; 2/

(b) Low prices in the free market; 3/

(c) Stagnation in the growth of world consumption and especially a decrease in consumption by the developed market economy sugar-importing countries;

(d) Reduced import requirements of the free market owing to declining consumption and the increasing self-sufficiency of some importing countries;

(e) The growing importance of white sugar in the international market;

(f) Increasing protectionism on the part of the developed market economy countries, principally the EEC, the United States of America and Japan, which has led to a reduction of their imports, an increase in their exports and consequently a shrinking of the market available to the other exporters as well as downward pressure on free market prices;

(g) The failure of attempts to regulate the international market by means of a Sugar Agreement with effective economic clauses;

(h) Rapid growth in many countries of consumption of caloric and non-caloric sugar-substitute sweeteners, such as high fructose corn syrup (HFCS) and aspartame.

The principal effects of the above situation in the sugar producing developing countries are a significant reduction in the value of their sugar exports in the world market and in the traditional preferential markets and a decrease in the volume of sugar exports and sugar-production itself. 4/ Considering the importance of the sugar industry to these countries, it must be recognized that the present crisis compels them to restructure this industry rapidly and to adapt it to new circumstances, and at the same time to seek effective solutions that will enable them to strengthen it so as to prevent the strangulation of a key sector of the economy.

2/ See table I, annex 1.

3/ See table II, annex 1.

4/ See tables II to VII, annex 1.

2. Prospects

When critical situations come to a head, it is essential to intensify the search for viable solutions, for which purpose an overall approach to sugar-cane processing is necessary; it should no longer be regarded purely and simply as a sugar industry but should be analysed as a sugar-cane agro-industry. On the basis of this more comprehensive approach, we can suggest the total use of this raw material as the first solution with real possibilities, which has unquestionably proved viable in many countries that already have experience of it; however, it would be necessary to study the feasibility of this approach for each particular country that wants to adopt the same course, since that will depend on specific country conditions.

Extracting the full benefit from sugar-cane implies the efficient direct or indirect use of all parts of the plant, the industrial processing and/or utilization of the by-products of sugar manufacture, and the manufacture of derivatives, that is to say, products other than sugar. It is with these considerations in mind that we refer to the desirability of diversifying the traditional sugar industry; for this purpose it is necessary to restructure, rehabilitate and modernize existing antiquated installations in most of the developing countries that produce and export sugar.

The manifold possibilities offered by diversification are well known, both in the agricultural and the industrial sphere; among its most obvious advantages are its contribution to reducing costs of production, which are distributed among a number of products, and to increasing earnings from the sale of these products in local and/or foreign markets, if some of them are to be exported.

The prospects of the sugar-cane processing industry are therefore linked to its diversification in the widest sense of the term. Though the range of possibilities is enormous, 5/ certain circumstances that hamper its development as well as regional or national peculiarities will have to be examined in detail in order to study the feasibility and applicability of diversification. Concurrently, it will be necessary to consider all of the indispensable requirements for outlining a coherent programme and for adopting a plan of action for its

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5/ See table I and figures A and B, annex 1.

implementation that will take into account both the requirements and real possibilities and resources in the short, medium and long term.

C. THE DIVERSIFICATION OF THE SUGAR INDUSTRY

As an agro-industrial system the sugar industry has poorly integrated and for the most part obsolete structures. Therefore, to ensure that this historic activity does not totally disappear, it is urgently necessary to tackle the problems that affect it, designing a global strategy for its reorientation and taking such decisions as may be necessary to put that strategy into effect.

1. Some general lines of approach to the problem

Many sectors in the economic life of the sugar producing developing countries are directly or indirectly linked to the cane sugar agro-industry; this is true of those countries in which the industry is State-owned and those in which it is in private hands or in which ownership is mixed. Also, a considerable proportion of government income comes from the taxes paid by the sugar sector. For that reason, the sector must be considered in the national macro-economic context so that it is necessary to analyse both the possible effects on other sectors of changes in the sugar sector as well as the guidelines to be laid down in order to foster the restructuring and later reorientation of this traditional industry.

The restructuring of the cane sugar industry involves both the physical installations and the operating systems of the various production units, and the mentality and attitudes of the people who work in the sector; changes in the two latter factors are of paramount importance for ensuring that the other changes are effective and even possible. It is therefore necessary in many cases to convince people by concrete proof of the advantages that changes might bring and even to re-educate people whose families have from generation to generation been working with sugar and sugar-cane and who have spent a good deal of their lives in the sector. To many of them it is difficult to understand that the sugar industry in its traditional form of operation does not fulfil the expectations of a constantly developing world and that, to meet the present demand for consumer goods in national and international markets, it is necessary to raise the value of sugar-cane as a raw material and to derive greater benefit from it than before, by extracting more products that can satisfy daily growing needs.

On the other hand, in the same way as the developed market economy countries have taken economic policy measures to protect domestic producers, the developing countries must also adopt policies for the protection of the cane sugar industry, at least until the process of diversification has gone beyond

the start-up and readaptation phase and is in full operation and the profitability level has been reached.

Another part of the restructuring process that must be dealt with is the rehabilitation of the physical infrastructure of this agro-industry, with the aim of modernizing it, and consequent optimization of efficiency in the various stages of the production process. In this context, rehabilitation implies a previous extensive and intensive evaluation of all existing and available resources of the sector, first adopting a general and then a specific approach by areas, to determine exactly what can be retained, what can be adjusted or improved and what must be replaced. Later the necessary innovations will be planned in the light of decisions that have been or may be taken with regard to the reorientation of the industry and the diversification of production.

2. Strategies for the reorientation of the industry and the diversification of production

Diversifying the cane sugar agro-industry presupposes the preparation of a co-ordinated plan of action for changing the traditional production activity of this sector. The strategy in the widest sense consists in deciding to produce the fullest possible range of consumer goods apart from sugar that would have an assured market and an acceptable price, in the light of the resources, characteristics and needs of each country, with the aim of satisfying other categories of users.

That decision must be a shared or a mixed one - involving the State and the private sector - even if the industry is wholly or mostly in private hands, since State participation and support is indispensable if the industry is to receive the protection that the State must give to permit the implementation of the investments required by the changes envisaged.

Once a decision on diversification has been taken, it remains to analyse the way in which it is to be carried out, that is to say, to answer the classic questions of what to produce, how to produce it and with what resources, for what markets the new products would be intended, when the process of diversification of production would commence, and in how many stages it would be carried out.

Finally, we must point out that the diversification of the traditional sugar industry can and must be regarded from two points of view - the agricultural and the industrial. As the present document deals essentially with the

industrial side, all that we shall say with regard to the agricultural aspect is that increased productivity of the sugar-cane plantations is of paramount importance for the profitability of the entire activity. This leads us to stress the need to cultivate the most productive varieties of sugar-cane in line with the objectives pursued and to apply the most efficient cultivation methods so as to obtain a larger quantity of sugar-cane from the area planted, or the same quantity from a smaller area, and to use part of such land, if possible, for other crops or for other purposes. It is also necessary to promote the system of crop alternation or rotation in order to derive maximum benefit from the soil. These practices are being adopted with excellent results in a number of sugar producing countries and many of these countries have devoted substantial resources to related research and development. The interchange of knowledge and experience by means of horizontal co-operation would therefore be of great value in this field.

2.1 Total use of sugar-cane

Sugar-cane offers many options. Attempts have often been made to illustrate them systematically, but again and again new possibilities emerge and have to be included. Some of them, however, are given as an indication - by no means exhaustive - in the annexed diagram. 6/

Sugar-cane is a grass with truly unlimited possibilities of use, so that we shall try to review summarily the forms in which it can be utilized, showing the possible options. There may be more than one choice and in each case the feasibility will depend on the availability of the raw material and of other resources and on the specific circumstances of the enterprise, the country or the region in question. It will therefore be necessary to carry out specific studies to evaluate the characteristics of each case and the viability of the projects that it is desired to undertake, considering the question both from the economic and the social point of view.

Taking as a reference the diagram quoted, 7/ we first see that, as a main raw material, sugar-cane can be used as forage directly after cutting. Some Latin American and Caribbean countries have done this with positive results,

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6/ See figure B, annex 1.

7/ See figures A and B, annex 1.

chiefly for pig but not cattle feed, because, according to the experiments of animal nutrition specialists, this feed system is not appropriate for ruminants; both "in vivo" and "in vitro" experiments have revealed that ruminants have difficulty in digesting the pith or central part of the bagacillo, the molecule of which must be broken down by means of a predigestion process (treatment with sodium hydroxide). In non-ruminants, however, no problems of this nature have arisen, so that peasants or small farmers who have pigs, for example, can use this method without major problems, thus replacing expensive animal feed sold on the market.

At a slightly higher scale of production, proven technologies exist for the use of a type of press or mill for extracting the sugar-cane juice, which is mixed with dry or semi-dry forage (cane tops and leaves or grass) or processed as a refreshing drink and canned for direct human consumption. This latter product, on an industrial scale, might also perhaps be exported.

When the sugar-cane is crushed in a press or mill of the type referred to, the bagasse and the cortex are separated; appropriate technology also exists for the use of this product in the manufacture of multi-purpose boards that are usually quite strong.

At the industrial level, of course, there is also the manufacture of sugar and alcohol from the juice. This alcohol can be used directly as a motor fuel (in hydrated form for specially designed vehicles or in anhydrous form for mixing with petrol). It can also be used in the pharmaceutical and alcohol industries and, more widely, in the alco-chemistry industry.

In the manufacture of cane sugar a number of by-products are automatically generated that serve in turn as raw materials for the manufacture of derivatives. The distillation of alcohol also yields by-products with various uses.

What we want to emphasize is the fact that, in its natural state, all parts of the sugar-cane can be used, which is why it is considered both by technical experts and the workers who have studied it and have become familiar with it as the most "noble" of all plants. Indeed, it is possible to obtain excellent harvests under optimum cultivation conditions, and certain varieties are suitable for particular purposes; it grows and multiplies under natural conditions or even if left untended and without the use of fertilizers, other agro-chemicals, irrigation or special care, and can remain on the land for many seasons and even sprout after innumerable cuttings.

Finally, let us point out that the sugar-cane stalk or the trash, that is to say, the leaves and the cane top, can be used not only as a source of forage. The latter part is also an excellent fuel for boilers and a fibre for the production of furfural and other derivatives; in its natural state it is very valuable as a soil reconstituent since it helps in nutrient uptake, at the same time protecting the ground-water layer. For this reason, when the cane is cut and leaves and top are removed, a layer of these wastes is left on the recently harvested field; when biodegradation takes place, this layer mixes with the soil and forms part of it.

2.2 By-products of the industrial processing of sugar-cane

The processing of sugar-cane in modern agro-industry involves two main products, sugar and alcohol, which can be produced separately in independent sugar mills and alcohol distilleries or concurrently or alternately in the same industrial complex, by attaching distilleries to sugar mills.

In either case, one by-product is always present, namely, bagasse, whose use as a fuel and as a raw material for the manufacture of other products is of great economic value. It could be said that this is the chief by-product of the industrial processing of sugar-cane.

(a) Bagasse

Bagasse is a fibrous residue that is obtained from the factory mills during the process of extracting juice for the manufacture of sugar or alcohol. Potentially, it is available in large quantities and experience has been acquired in its handling, storage and transportation. Chemically speaking, bagasse consists of cellulose, hemicellulose and lignine; morphologically speaking, it consists of 60 per cent fibre, 30 per cent pith and 10 per cent fines and solubles.

Bagasse has traditionally been used as a fuel in the sugar industry. In fact, the energy systems of the sugar factories were originally designed on the basis of burning all of the bagasse produced, since there was no other use for it and its accumulation tended to constitute a problem. Later, when it became a valuable raw material for the production of several derivatives, it was partly replaced by petroleum as the result of the latter's low price; from 1974, when the oil price began to rise, the situation changed, making it necessary to

replace petroleum by bagasse again, but using more efficient burning methods, in order to generate surpluses for the derivatives industry.

The seasonal nature of the sugar industry makes it necessary to have large stocks of bagasse available so that the derivatives industry can operate throughout the year. However, it is possible to increase the volume of surplus bagasse after satisfying the energy needs of the factory and marginal demand, by making investments to optimize the plant's energy generation system. Bagasse can be stored in compacted or bulk form; the compacting system was the first to be used, but the bulk system has economic advantages that now make it preferable in most cases. The utilization of bagasse for the manufacture of pulp for making paper or board requires the separation of the fibre by depithing, which can be carried out by a dry, wet and/or suspension process. Proven technologies exist for using the pith, which constitutes between 30 and 40 per cent of total bagasse, for the generation of energy and as animal feed.

World-wide, the commonest products yielded by the industrial processing of bagasse are pulp and paper, pressed boards or panels, and furfural and its derivatives. However, the use of bagasse as a raw material calls for a study of various technico-economic factors, ignorance of which could make it difficult to process this valuable by-product. These are: the need for surpluses and knowledge of the best methods for obtaining them; the establishment of factories with capacities commensurate with those of the sugar mills and situated close to them; a link between the sugar mill and the derivatives plant; the study of bagasse and the best ways of handling and treating it in order to improve efficiency of operation.

(a.1) Derivatives of bagasse

(i) Pulp and paper

The greatest development in the industrial use of bagasse has been in the production of pulp and paper. There are more than 70 plants throughout the world, with a total capacity of approximately 2.5 million tons per annum, and there are also several projects for new installations to manufacture various types of pulp and paper in sugar-cane producing regions. A total of more than 27 countries use bagasse in making pulp and paper, most of them being in Asia and Latin America.

The expansion of the bagasse-based pulp and paper industry is important owing to the high world prices of these products and to the scarcity

of renewable raw materials, especially of the short-term type such as sugar-cane. The world trend indicates that, in the last 25 years, there has been a notable increase in the production of paper from bagasse. Demand for pulp and paper exists in most of the sugar-cane producing countries, so that it might be very interesting to study the feasibility of installing new factories that would satisfy demand in domestic markets and in other neighbouring markets in the same region.

(ii) Agglomerated products

Agglomerated products are large panels that are manufactured by bonding together particles of lignocellulosic materials (wood chips, shavings, bagasse, etc.). Bagasse can be used to produce particle board, fibre board, mouldings and bagasse-cement boards, which can replace natural woods and plywood in many uses. There are more than 40 factories for bagasse particle and fibre board throughout the world, most of them being in Latin America and Asia.

The most widespread use of particle boards is in the furniture industry. There is such a close interrelation between the two industries that in some countries they constitute an integrated complex. The principal applications of such boards are in kitchen cabinets or furniture, cupboards, desks, and household furniture in general. Depending on their density, particle boards are used as divider panels or as material for shuttering in construction. Almost all of the countries that produce them use them internally, since the greatest profitability that can be derived from boards is by the manufacture of a finished product that is to say, furniture.

Fibreboard, according to its density, may be of extra-porous, insulating, semi-hard, hard or extra-hard grade. Fundamentally, it is used in the construction industry for divider panels, doors, heat or sound insulation, decoration (after appropriate surface treatment) and also in the furniture industry for cabinets, drawers or chests and other furniture components.

(iii) Furfural and derivatives

Furfural can be obtained only by the hydrolysis of agricultural and forestry waste. To produce furfural from bagasse, it is not necessary to carry out depithing, and the lignocellulosic residue that is obtained can be used as a fuel in the process itself. Furfural is used as a raw material for the production of furfuryl alcohol, tetrahydrous furfuryl alcohol,

tetrahydrofuran and other derivatives and is used as a selective solvent in the production of anticorrosive types of plaster, plastic concrete, herbicides, insecticides, fungicides and pharmaceuticals, nylon 66, and so on.

More than 90 per cent of the furfural that is produced in the world is consumed in the industrialized countries, and about 75 per cent of this quantity is converted into furfuryl alcohol, so that the development of the foundry industry can significantly influence future consumption of furfural. There are several plants for the production of furfural from bagasse, some of which are in Latin America and the Caribbean. One of the most efficient is that of the La Romana sugar mill in the Dominican Republic, which exports all of its output.

(iv) Dissolving pulp and derivatives

Dissolving pulp is used in the production of rayon staple fibre, textile yarn, carboxymethyl cellulose, cellophane, and so on.

According to some experts, bagasse is used as a raw material for the production of dissolving pulp only in the People's Republic of China, on a semi-industrial scale, with capacities of between 3 and 10 tons/day. In Cuba it is also intended to produce dissolving pulp from bagasse on a semi-industrial scale (3 tons/day) in the specialized installation of project Cuba-9 (UNDP/ICIDCA).

(v) Bagacillo/pith

This by-product is yielded in depithing the bagasse for the manufacture of pulp, paper and boards and its chemical composition differs little from that of the fibrous part or from that of total bagasse, although there is a higher ash content. Its calorific value is similar to that of bagasse and, being a cellulosic product, it can be used for generating steam and electricity, for animal feed, as a raw material in the production of furfural and hydrolytic molasses, as a soil conditioner, and as a vehicle for pesticides and herbicides. It has traditionally been mixed with molasses for animal feed in various forms, such as molasses urea bagacillo and predigested bagacillo.

Efforts have been made throughout the world to use it as a fuel, and countries such as Hawaii, Mexico, Peru and Taiwan burn it efficiently in boilers designed specifically for the purpose, adding 10-15 per cent of oil by injection to maintain stability. Research is also going on into its use as a raw material for the production of furfural and hydrolytic molasses.

(b) Molasses

Molasses, or final molasses, comes in the form of a dense liquid as a residue of the crystallization phase in the manufacture of sugar. It contains between 50 and 58 per cent of total sugars and has a metabolizable energy of approximately 2,200 kcal/kg.

In general, molasses has many uses both as animal feed and in industry. Its major direct and indirect use throughout the world is in animal nutrition, for which purpose many developed countries not only produce it domestically but also import large quantities from other regions.

Industrially, it is used mainly for the production of alcohol, as is the case in almost all sugar-cane producing countries. Many other derivatives such as lysine, yeasts, citric acid, monosodium glutamate, etc. can also be obtained. The price of molasses in the international market is subject to great fluctuations. Almost all of the types of molasses sold in the world market come from sugar-cane, since the beet-sugar producing countries consume their molasses domestically. The EEC, the United States of America and Japan consume about 80 per cent of the molasses sold in the world market. The use of molasses depends on the policy of each country. However, its direct production is related to the availability of land for sugar-cane growing and the desirability of producing greater or smaller quantities at particular times, either for consumption or export.

(b.1) Derivatives of molasses

(i) Yeasts

The production of yeasts does not present any great technological difficulty and the equipment required is that traditionally used in the fermentation industry.

The best known yeasts are saccharomyces and torula yeast. Saccharomyces or baker's yeast is produced in almost all countries for making bread and pastry goods in general. The form that is recovered in the production of alcohol is frequently used in animal nutrition.

Torula or forage yeast is a source of proteins and vitamins and is used in the formulation of mixed animal feed. It is of great importance to developing countries that have molasses available. Yeasts, especially

saccharomyces and torula, must be processed to reduce their nucleic acid content so as to make them fit for human consumption.

(ii) Lysine

Lysine is an essential amino acid that is used as an additive in animal nutrition. It is found in soya cake and fish meal, and in a lower proportion in cereals. It is produced industrially from sugar-cane molasses in Japan and Mexico.

(iii) Citric acid

Citric acid is obtained by the fermentation of molasses. It is used as a preservative and as an acidulant to enhance the flavour of food products and beverages. Traditionally, it is made from beet molasses; as far as is known, it is only in India that it is produced from sugar-cane molasses.

(iv) Monosodium glutamate

This is one of the best known flavourings in the food industry, Japan being the main producer. It is also produced in France, Italy, Taiwan, the United States of America and the EEC, and in other countries, some of which are in Latin America.

(v) Dextran

Dextran is a polymer of glucose with a high molecular weight that is obtained by the fermentation of sucrose, "guarapo" or molasses. Technical dextran has properties similar to those of cellulose derivatives and is used for the production of clinical dextran by a well-known technology. Its most important use is as a substitute for blood plasma.

(vi) Other uses of molasses

In most sugar producing countries, much of the molasses consumed locally is used direct, mixed with water as a diet supplement for cattle and pigs. However, concurrently with its price rise in the international market, its domestic price has also been increased in order to make more supplies available for export, and this has led to more rational use by cattle farmers.

The rest of the domestically consumed molasses is intended for the fermentation industry, chiefly in the distillation of alcohol for pharmaceutical use and in the production of rum and other alcoholic beverages,

according to the habits and customs of each country or region, both for domestic consumption and for export.

(c) Filter cake

The residue obtained from the filtering of juice in the production of sugar is called filter cake and its volume varies according to the efficiency of the plant. No very valuable use has been found for it, and, as it is a waste product, it must be disposed of. It has been used for watering fields or in irrigation channels and in concentrated form for cattle and pig feed.

So far, the most promising use of filter cake is for the production of refined wax for adhesives, for coating food products and fruit, in crafts activities, for bitumens, cosmetics, polishes and other purposes.

Refining of the crude wax gives hard wax, resins and oil. The latter is used in animal nutrition.

2.3 Other prospects for the use and industrial processing of by-products of the cane sugar agro-industry and the production of derivatives

The cane sugar agro-industry offers the producer countries a broad raw materials base for developing the industrial manufacture of many consumer goods. The production of derivatives in turn is closely linked with the sugar industry, owing to the quantities of by-products that are obtained during the sugar production process and to the economic aspects of the interconnection between the various processes. Hence, the importance of the size and capacity of plants, the distance between them and the degree of technological development of agricultural and factory operations.

Though there are many possibilities for the diversification of the sugar industry, derivatives cannot be manufactured concurrently and under the same conditions in all sugar-cane producing countries. Diversification will always depend on the characteristics of each region and of the constituent countries.

Also, in order to select the most appropriate alternatives, it is necessary to study carefully all aspects related to the problems involved in the industrial processing of derivatives that directly concern the sugar producing countries, such as the fluctuations of sugar prices, changes in the sugar industry, market problems, economies of scale and profitability.

(a) Sugar

Many forms of sugar or sucrose are on the market and are presented in different forms and according to different nomenclature, depending on the intended use (direct, for pastry-making, as an input in the food industry, etc.). Among others, one can quote refined or white granulated sugar, raw, muscovado or brown sugar, liquid sugar or syrup, unrefined sugar loaf, "raspadura" or "chancaca", refined or "turbinado", direct white sugar, etc., as well as some variants such as icing sugar, cubes or other moulded forms, and sugars to which other products such as pectin, vanilla, etc. are added to alter its appearance or flavour.

One direct use of sugar that is giving excellent results in Colombia is for poultry feed as an energy substitute for sorghum. At the moment, more than 14,000 tons/month are being used for this purpose, and it is planned to expand this market to up to some 200,000 tons/year.

Liquid sugar is one of the most widely accepted forms of this product among industrial users, since it facilitates certain processes and makes them less expensive. The technology for the production of liquid sugar has developed substantially, and high levels of efficiency in terms of quality, appearance and costs have been achieved. Along these lines, an outstanding achievement is the process developed in France for the separation of saccharides and non-saccharides from resins in the production of liquid and crystalline sweeteners, by ion exchange. Through this process, a high degree of decoloration is achieved in the production of liquid or granulated sugar (depending on the demand of the market that is to be satisfied); it is also possible to use the ion exchange method to produce liquid sugar from molasses, in which case the following by-products are obtained: hydrolysed protein for animal feed and crystallized salts containing ammonium and potassium sulphate for use as fertilizers. This is equivalent to upvaluing the non-saccharide agents in general and, in the final analysis, molasses in particular.

It is obvious that the possibilities for marketing sugar with some value added content and its price in the market are direct functions of its competitiveness in quality and presentation.

We should finally indicate the great negative effect on the consumption of sugars that has been exerted by the substitute sweeteners, for instance, glucose, dextrose, HFCS, and the so-called "low calorie" products such as the polyhydrides (sorbitol, mannitol, lycasin, xylitol and maltitol), the cyclamates,

saccharine, aspartame, acesulfame-K and stevioside. Owing to their properties, these high-intensity sweeteners are being increasingly used in the preparation of diet foods and medicaments for mass consumption. Similarly, the liquid forms, especially HFCS, have captured a large part of the international market for sweeteners, principally for the manufacture of carbonated beverages, milk products and processed foods.

(a.1) Sucrochemistry

Sucrochemistry has a long history of development and there are more than 10,000 products derived from sucrose whose processing is technically feasible and in many cases economically viable. In general terms, there are three technically proven and economically profitable methods for producing derivatives and other products from sucrose, namely, fermentation, synthesis and conversion. These methods yield a number of commercially interesting chemical products, including enzymes, medicaments, sucrose esters (for the manufacture of plasticizers, paints and adhesives), polyurethane (for heat insulation), sorbitol, mannitol, glycerine, propylene glycol, oxalic acid, fructose, carbonic acid, levulinic acid, hydroxymethyl furfural and lactic acid. There is a consolidated captive market for each of these products in which sucrose derivatives can compete with derivatives of other raw materials.

(b) Alcohol

The most widespread use of alcohol or ethanol has been in the liquor and pharmaceutical industries and to a smaller extent in the cosmetics and perfumery industries. Nevertheless, from the 1970s, a radical change took place in the traditional use of alcohol, when PROALCOOL was launched in Brazil. With the official commencement of this programme, the authorities of this important Latin American country decided to reduce cane sugar output and use some of the sugarcane to produce alcohol, as a substitute for petrol. The production of alcohol directly from cane juice has been progressively increased and its use as a fuel has been diversified in the process. Thus, in the form of absolute or anhydrous alcohol, it is mixed with petrol up to a proportion of approximately 20 per cent, while hydrated alcohol is used directly in internal combustion engines designed especially for the purpose. This has stimulated the development of the automotive industry and the production of related machinery and equipment, both for the domestic market and for export.

Alcohol is used as a fuel in several parts of the world. In the Latin American region, a number of countries have followed the Brazilian example with similar aims or for exporting to other markets and it is almost certain that many others will adopt the same course.

(b.1) Alcochemistry

Since alcohol is a chemical product that can be transformed into ethylene, ethene or acetaldehyde, it is also used in the development of the chemical industry. Ethylene, or ethene, a product almost exclusive to the petrochemical industry, can be economically produced from ethanol; from ethylene, it is possible to manufacture inter alia polyethylene, PVC and other plastics, synthetic fibres, herbicides and insecticides. Also, ethyl acetate, acetaldehyde, butanol, butadiene and 2-ethyl-hexanol can be produced from ethanol by direct chemical reaction. All of these products have captive markets within the chemical industry as raw materials for the synthesis of other chemical products and the manufacture of consumer goods for which there is great demand throughout the world.

Given acceptable prices, sugar and alcohol can compete as raw materials for the chemical industry, which has so far been based mainly on petroleum. However, as the latter is a non-renewable resource, it is absolutely necessary to intensify the use of other raw materials; there are technically and economically feasible production processes based on sucrose and ethanol, and these two raw materials have the additional advantage that they come from a renewable resource, namely, sugar-cane. Sugar-cane is also an excellent basis for the manufacture of many liquid or low-calorie sweeteners by the processes mentioned above, and these products also have the potential to compete with the sugar substitutes that have caused the decline in demand.

D. POTENTIAL MARKETS FOR DERIVATIVES

The identification of potential markets for derivatives is one of the greatest problems facing developing countries that wish to commence, or have already commenced, diversification of their sugar industries.

In fact, many by-products can be used direct purely at national level, but derivatives of their industrial processing can largely be exported. Also, to be economically profitable, some industrial installations for the production of derivatives must have capacity exceeding the domestic demand of most of these countries, since their markets are of small or medium size, according to the product in question. Hence it is important to be aware of possible markets for the new products as well as their requirements and conditions with regard to quality, presentation and other characteristics, which are indispensable for successful competition with similar products.

The problem we have in mind is that, in the view of some experts, although several countries make studies of the domestic market and even of the regional and international markets before installing a plant for the production of one or more derivatives, these studies are not sufficiently realistic and objective. In the main, they are very optimistic, since they are based on an analysis of the situation for the supply of unprocessed products and on statistical series, from which it is assumed that the potential market is equal to the apparent demand revealed by the data; in the long run, this leads to the collapse of projects.

For all of the above reasons, the reality has to be faced that the sugar producing countries must reorient their traditional industry by diversifying their production so as to make it profitable and at the same time practise import substitution and/or increase their exports when they have comparative advantages for taking this course. However, beforehand, it is essential to carry out realistic technico-economic feasibility studies and objective and precise market studies that take into account all information on the characteristics and peculiarities of markets. Such studies are expensive and many countries do not have the financial resources to pay for them; then, technical and financial assistance from the developed countries is a decisive factor in the case of those countries or groups of countries in certain regions for which this problem constitutes a major obstacle in industrial development.

Organizations such as the Group of Latin American and Caribbean Sugar Exporting Countries (GEPLACEA) offer technical assistance to their member

countries and have carried out market studies for specific derivatives of the cane sugar agro-industry, with the support of United Nations agencies. In the same way, some Governments of developed countries are setting up special funds for assistance to the developing countries, which have sometimes also been used for these purposes.

The prospects for developing the production of derivatives for export are therefore closely related to marketing possibilities and the feasibility of production under the most favourable conditions.

E. DEVELOPMENT OBSTACLES IN THE DIVERSIFICATION OF THE CANE SUGAR INDUSTRY

The reorientation of the traditional sugar industry towards diversification of production based on the concept of a cane sugar agro-industry implies profound changes in existing structures, which in turn makes it necessary to consider a number of aspects that constitute real development obstacles for that industry. Among these, we shall deal chiefly with the financial and management aspects.

1. Financial aspects

The availability of financial resources is one of the most pressing problems of the developing countries. Their capacity for generating capital to satisfy the most urgent domestic needs is being progressively diminished by the decline in international prices for their traditional export products - mostly raw materials of agricultural origin - and is further weakened by the rise in the prices of the imports that they need for subsistence. If we add to this the impossibility of using normal financing sources because of the magnitude of their external debt with international banks and with some developed countries, we can see that there is a major problem that can be solved only by concerted dialogue with the object of achieving negotiated agreements between the parties.

It is worth pointing out that the problem also arises in the case of interregional or international financing agencies. Apart from being heavily indebted to those institutions, the countries receive financial assistance with strings which are required to meet special conditions not always acceptable for them from socio-economic points of views.

However, as it is necessary to have recourse to international financial institutions, the most appropriate ways must be sought for concluding agreements that enable the countries to obtain funds from these sources without having to take internal action that would create socio-economic problems.

An interesting alternative for the cane sugar agro-industry in the producer countries could be the execution of diversification projects on the basis of mixed government and private sector financing, where these sectors have appropriate resources for the purpose. Other variants would be an association between national and foreign capital through the joint venture system or an

attempt to attract foreign investment and channel it to the cane sugar agro-industrial sector by creating special incentives that would guarantee the safety and profitability of the investments.

2. Management aspects

Restructuring involves a series of administrative and functional changes whose social, political and economic repercussions must be foreseen when planning the diversification of the sugar industry. In fact, when changing the orientation of the sector and existing production patterns, special problems related to modernizing installations and processes emerge in the enterprises; this entails redeploying equipment and staff, eliminating existing production units or establishing new ones.

At the micro-economic level, the optimization of processes requires the training and redeployment of various categories of workers. This, combined with the possible need to close plants that are no longer profitable owing to their obsolescence and inefficiency, leads to job losses and thus generates unemployment for a number of persons who would have difficulty in finding work in the same sector. It is therefore important to plan the new cane sugar agro-industry according to government guidelines, taking into account the macro-economic environment, which facilitates the solution of such problems. In most of the sugar producing countries there are public or semi-public agencies that are officially and formally in charge of policy for the sector; their direct participation in the planning activities mentioned above is a decisive factor.

F. INTERNATIONAL CO-OPERATION

Many of the problems that have already been identified, as well as others that have not been mentioned, constitute obstacles that hamper the development of the cane sugar agro-industry or make it more difficult. However, some countries of Latin America, the Caribbean, Asia and the Pacific have succeeded in overcoming such obstacles, achieving some degree of development in the sector and initiating a stable diversification process. There are very marked differences in the degree of development of the various countries, from the most advanced to the most backward - through all of the intermediate levels. This indisputably facilitates complementarity between them in the form of both intraregional and interregional technological exchange and co-operation.

The transfer of knowledge and experience among developing countries is of great importance in achieving growth objectives for their industries and strengthening their economies. It is therefore necessary to intensify South-South co-operation by concluding bilateral and multilateral agreements that enable these countries to strengthen national and regional markets, taking into account the need to reduce their dependence on the international market for sugar and other traditional export commodities. These efforts, however, would be more effective if the real support of the developed countries were forthcoming, since in the ultimate analysis the improvement of the economic, social and political situation of the developing countries must be in the interest of the developed countries as well. Such support would enable the developing countries to create the conditions for paying off or at least reducing the amount of their external debt without major internal disequilibrium.

North-South co-operation is therefore a decisive factor and is urgently needed in order to achieve the development aims of the southern hemisphere bloc of countries, for the benefit of the countries in the northern hemisphere themselves; such collaboration must be both bilateral and multilateral, covering specific priority interest sectors, but on the basis of mutual respect with regard to internal affairs that concern the national policies of both parties.

Financial assistance and direct or indirect technical assistance through international and regional agencies are efficient forms of North-South co-operation that have so far yielded positive results; however, they have not been practised on the scale required by the circumstances but have rather been timid or limited in scope and have at times been determined by the interests of the parties that grant the aid or have the resources to offer it. It must be

recognized in this context that the cane sugar industry, which has been affected by the economic policies of the developed importing countries, is one of the sectors to which the least attention has been given in international co-operation, although it has for a considerable time been of priority importance to the developing countries that produce sugar-cane and export sugar.

G. FINAL CONSIDERATIONS

Although the sugar producing developing countries have become aware of the need to tackle their main problems and are trying to look for viable solutions with future prospects, the success achieved has been unequal from country to country and from region to region; in fact, their efforts to find the comprehensive solution that the cane sugar agro-industry calls for have been inadequate.

Regional agencies such as GEPLACEA have been contributing for many years to the search for feasible solutions to deal with the crisis in Latin America, which, although it affects all spheres of these countries' economies, has a great negative impact on the sugar sector. Joint action by similar agencies and countries in other regions would undoubtedly help to achieve this common goal.

The UNIDO System of Consultations is taking an interest in the cane sugar processing industries of a large group of countries in the East and the West; these countries are in widely dispersed geographical regions but they have common problems and also suffer the same effects. Solutions must therefore be found, on the basis of guidelines such as those suggested below:

- Intensifying the study of international markets for sugar, alcohol, molasses and other by-products and derivatives;
- Defending the prices of these products in traditional and non-traditional international markets;
- Continuing efforts to conclude a new International Sugar Agreement with effective economic clauses;
- Strengthening regional agencies and associations of producers and supporting their establishment where there are none, in order to carry out co-ordinated common action;
- Increasing the value added content of export products, winning a greater share of the white sugar market and increasing the production and sale of derivatives;
- Promoting the establishment of joint ventures among countries in one and the same geographical area for the production and sale of services and consumer goods and of capital goods for the cane sugar agro-industry;

- Combating campaigns against the consumption of sugar, both national and international;
- Including the subject of sugar in the discussions of UNCTAD/GATT and other related international forums;
- Cultivating improved varieties of sugar-cane in the various countries that will be better suited to new trends in the cane sugar agro-industry, by means of regional and interregional co-operation and exchange programmes;
- Mechanizing agricultural work as far as possible;
- Designing regional programmes for the production, exchange and maintenance of agricultural machinery and equipment;
- Modernizing sugar factories, especially with regard to energy optimization;
- Establishing efficient preventive maintenance programmes for factory installations;
- Giving priority to the diversification of the cane sugar agro-industry, thus reducing dependence on a single product;
- Co-ordinating technological development and research activities as well as training and transfer of technology, knowledge and experience.

These proposed solutions are not mutually exclusive but complementary and their combined implementation will be of help in coping with the critical situation.

We should also emphasize that, as a preliminary step, it is necessary to reach agreement at international level among all of the market participants, both exporters and importers, in order to seek comprehensive and permanent solutions for the commodity markets since, although the most urgent measures are of a domestic nature and thus within the strict individual sphere of responsibility of the countries, comprehensive solutions can be implemented only through a commitment on the part of all of those concerned, first at regional level and then at global level.

The regional and global solutions should clearly take into account differences between countries and their specific production and marketing methods, in the size of their domestic markets, their shares of different markets as well as the degree of development of their economies and diversification of their cane

sugar agro-industries. The developed countries should take these difficulties particularly into consideration in designing their collective policies, because commodities are of greater relative importance in the developing countries.

There is a clear need for co-ordination among the regional organizations of the countries producing sugar and other commodities as well as for greater co-ordination between such organizations and the international agencies, since joint action, involving the active presence of the large and small developed and developing countries, could give positive results for the benefit of all, an end that could hardly be achieved through separate action. Co-ordinated action, however, is possible only on the one hand through the political will and decisions of the Governments that are members of the regional and international agencies, that control them and determine their goals, and on the other hand through the support of the private entrepreneurial sectors that have the necessary financial resources to undertake the activities and implement the measures that would permit the creation of new industrial capacity in the developing countries, balanced growth of their economies and the establishment of a New International Economic Order with the prospect of a better future for all.

DIVERSIFICATION OF THE CANE SUGAR INDUSTRY

ANNEXES

ANNEX 1

STATISTICAL TABLES, FIGURES AND TABULATIONS

INDEX

TABLE I

WORLD SUGAR BALANCE

1962-1986

1,000 MTRV | Kg

Year	Produc.	Consump.	P. stocks	Export	Import	Per cap. cons.
1962	51,227	53,455	23,851	18,529	18,297	17.3
1963	51,894	54,343	20,867	16,869	16,621	17.3
1964	59,319	54,158	24,564	16,826	16,316	17.2
1965	63,790	57,962	28,226	18,649	18,120	18.0
1966	62,741	59,754	29,355	18,235	18,231	18.3
1967	65,026	61,602	31,395	20,197	19,622	18.5
1968	65,411	64,744	31,030	20,589	19,225	19.1
1969	68,140	66,847	32,345	18,571	19,769	19.3
1970	71,142	70,480	31,586	21,808	21,339	19.9
1971	71,975	72,457	30,644	21,035	20,644	20.3
1972	73,735	73,660	30,109	21,871	21,234	20.4
1973	75,789	76,330	29,343	22,478	22,427	20.7
1974	76,397	77,303	27,895	22,097	21,519	20.0
1975	78,846	74,438	32,065	20,599	20,495	18.9
1976	82,400	79,241	34,266	22,794	21,783	19.7
1977	90,350	82,592	40,623	28,471	26,869	20.2
1978	90,832	86,354	43,630	25,072	24,807	20.7
1979	89,342	90,287	41,639	25,985	25,058	21.2
1980	84,489	88,590	37,455	26,832	26,746	20.2
1981	92,769	90,022	39,126	29,142	28,222	19.8
1982	101,810	92,637	47,270	30,427	29,587	20.2
1983	96,911	93,606	49,153	28,981	27,730	20.0
1984	99,217	96,348	51,357	28,485	27,973	20.3
1985	99,551	97,778	51,654	27,762	26,510	20.2
1986	100,222	100,854	51,147	26,692	27,064	20.4

NOTE: Production, consumption, imports and exports in 1,000 MTRV.
Per capita consumption in kg.
Prices in US ¢ per lb.

Source: International Sugar Organization

TABLE II

RAW SUGAR WORLD PRICE

Annual averages 1948-1987

	Nominal ¢/lb	Deflated ¢/lb	Nominal $/mt	Deflated $/mt	Index 1975
1948	4.23	9.61	94.78	215.40	0.44
1949	4.16	10.15	93.21	227.34	0.41
1950	4.98	13.46	111.58	301.57	0.37
1951	5.67	12.89	127.04	288.73	0.44
1952	4.17	9.27	93.43	207.63	0.45
1953	3.41	7.93	76.40	177.68	0.43
1954	3.26	7.76	73.04	173.91	0.42
1955	3.24	7.53	72.60	168.83	0.43
1956	3.48	7.73	77.97	173.27	0.45
1957	5.16	11.22	115.61	251.34	0.46
1958	3.50	7.78	78.42	174.27	0.45
1959	2.97	6.60	66.55	147.88	0.45
1960	3.14	6.83	70.35	152.95	0.46
1961	2.91	6.19	65.20	138.73	0.47
1962	2.98	6.34	66.77	142.06	0.47
1963	8.50	18.09	190.45	405.21	0.47
1964	5.87	12.23	131.52	274.01	0.48
1965	2.12	4.33	47.50	96.94	0.49
1966	1.86	3.80	41.68	85.05	0.49
1967	1.99	3.98	44.59	89.18	0.50
1968	1.98	3.96	44.36	88.73	0.50
1969	3.37	6.48	75.51	145.21	0.52
1970	3.75	6.94	84.02	155.60	0.54
1971	4.52	7.79	101.28	174.61	0.58
1972	7.41	11.95	166.03	267.79	0.62
1973	9.59	13.14	214.87	294.35	0.73
1974	29.60	33.26	663.22	745.19	0.89
1975	20.49	20.49	459.10	459.10	1.00
1976	11.60	11.60	259.91	259.91	1.00
1977	8.11	7.44	181.71	166.71	1.09
1978	7.81	6.25	174.99	139.99	1.25
1979	9.87	6.90	221.15	154.65	1.43
1980	29.01	18.36	650.00	411.39	1.58
1981	16.93	11.40	379.33	255.41	1.49
1982	8.55	5.88	191.57	131.79	1.45
1983	8.50	6.04	190.45	135.44	1.41
1984	5.18	3.81	116.06	85.42	1.36
1985	4.09	2.98	91.64	66.67	1.37
1986	6.07	3.69	136.00	82.77	1.64
1987	6.71	4.08	150.34	91.49	1.85

Source: Prepared by GEPLACEA

TABLE III

LATIN AMERICA AND THE CARIBBEAN

SUGAR STATISTICS

1,000 MTRV

Year	Pro-duction	Con-sumption	Prod. - Cons.	Export	Import	Exp. - Import	Per capita consumption
1969	18,996	9,751	9,245	9,147	304	8,843	33.74
1970	21,998	10,099	11,899	11,563	170	11,393	34.22
1971	21,141	10,683	10,458	10,598	247	10,351	35.54
1972	21,084	11,100	9,984	11,154	367	10,787	36.25
1973	23,970	11,525	12,445	11,937	402	11,535	36.95
1974	24,027	12,248	11,779	12,193	267	11,926	38.55
1975	23,597	12,950	10,647	11,168	259	10,909	40.02
1976	25,096	13,349	11,747	10,577	248	10,329	40.50
1977	27,246	13,550	13,696	13,041	651	12,390	40.36
1978	27,133	14,119	13,014	12,575	721	11,854	41.28
1979	26,508	15,135	11,373	12,853	668	12,185	43.45
1980	26,028	15,717	10,311	12,039	1,672	10,367	44.29
1981	27,383	15,451	11,932	12,853	1,593	11,260	42.75
1982	28,306	15,921	12,385	13,456	1,507	11,949	43.24
1983	28,479	15,559	12,920	13,336	1,856	11,480	41.49
1984	28,812	16,211	12,601	13,180	1,230	11,950	42.44
1985	28,057	16,561	11,496	12,466	409	12,057	43.26
1986	27,771	17,145	10,626	11,709	471	11,238	43.50
Averages							
69-71	20,712	10,178	10,534	10,436	240	10,196	34.50
74-76	24,240	12,849	11,391	11,313	258	11,055	39.69
79-81	26,640	15,434	11,205	12,582	1,311	11,271	43.50
84-86	28,213	16,639	11,574	12,452	703	11,748	43.07
Percentage change							
75-70	17.04	26.25	8.14	8.40	7.35	8.43	15.04
80-75	9.90	20.12	- 1.63	11.22	408.14	1.95	9.59
85-80	5.91	7.81	3.29	- 1.03	- 46.35	4.24	- 0.99

Per capita consumption in kg.

Source: Prepared by GEPLACEA, with figures from the International Sugar Organization
Bibliography Nos. 2 and 3, annex 2.

TABLE IV

ASIA

SUGAR STATISTICS

1969 - 1986

1,000 MTRV

Year	Pro-duction	Con-sumption	Prod. - Cons.	Export	Import	Exp. - Import	Per capita consumption
1969	10,422	12,999	- 2,577	1,951	5,578	- 3,627	6.50
1970	11,802	14,487	- 2,685	2,259	5,893	- 3,634	7.20
1971	11,621	15,578	- 3,957	2,722	6,034	- 3,312	7.70
1972	11,180	15,776	- 4,596	2,584	6,357	- 3,773	7.50
1973	11,736	15,817	- 4,081	2,724	6,718	- 4,057	7.50
1974	13,357	15,877	- 2,520	3,585	6,242	- 2,657	7.40
1975	14,182	15,332	- 1,150	3,703	6,043	- 2,340	7.00
1976	15,564	16,743	- 1,179	4,405	6,052	- 1,647	7.40
1977	16,616	19,059	- 2,443	5,430	8,457	- 3,027	8.30
1978	17,866	21,212	- 3,346	3,485	8,424	- 4,939	9.10
1979	17,609	23,382	- 5,773	3,749	8,642	- 4,893	9.80
1980	14,697	21,289	- 6,592	3,395	8,721	- 5,326	8.50
1981	18,219	23,178	- 4,959	3,510	8,623	- 5,113	8.60
1982	24,403	25,054	- 651	4,676	10,192	- 5,516	9.40
1983	21,985	26,342	- 4,357	3,973	8,553	- 4,580	9.70
1984	21,971	28,224	- 6,253	3,676	9,517	- 5,841	10.40
1985	22,290	30,197	- 7,907	3,343	11,085	- 7,742	10.90
1986	23,541	30,879	- 7,338	3,136	10,445	- 7,309	11.00
Averages							
69-71	11,282	14,355	- 3,073	2,311	5,835	- 3,524	7.13
74-76	14,368	15,984	- 1,616	3,898	6,112	- 2,215	7.27
79-81	16,842	22,616	- 5,775	3,551	8,662	- 5,111	8.97
84-86	22,601	29,767	- 7,166	3,385	10,349	- 6,964	10.77
Percentage change							
75-70	27.35	11.35	- 47.40	68.68	4.75	- 37.16	1.87
80-75	17.22	41.49	257.27	- 8.89	41.71	130.76	23.39
85-80	34.19	31.62	24.09	- 4.68	19.48	36.26	20.07

Per capita consumption in kg.

Source: Prepared by GEPLACEA, with figures from the International Sugar Organization
Bibliography No. 3, annex 2.

TABLE V

AFRICA

SUGAR STATISTICS

1,000 MTRV

Year	Pro-duction	Con-sumption	Prod. - Cons.	Export	Import	Exp. - Import	Per capita consumption
1969	4,329	3,822	507	1,984	1,246	738	11.20
1970	4,606	4,114	492	2,020	1,540	480	11.80
1971	4,939	4,449	490	2,047	1,664	383	12.40
1972	5,391	4,597	794	2,320	1,713	607	12.60
1973	5,376	4,841	535	2,366	1,748	618	12.80
1974	5,419	4,947	472	2,194	1,791	403	12.70
1975	5,219	5,100	119	1,851	1,699	152	12.80
1976	5,690	5,448	242	2,138	2,104	34	13.40
1977	6,113	5,887	226	2,873	2,569	304	13.90
1978	6,069	6,202	- 133	1,927	2,948	- 1,021	14.30
1979	6,171	6,518	- 347	2,259	2,643	- 384	14.30
1980	5,970	7,044	- 1,074	2,357	3,052	- 695	15.10
1981	6,453	7,537	- 1,084	2,111	3,505	- 1,394	15.70
1982	7,024	7,690	- 666	2,392	3,537	- 1,145	15.00
1983	6,450	7,983	- 1,533	2,211	3,647	- 1,436	12.10
1984	7,088	7,826	- 738	2,206	3,373	- 1,167	14.50
1985	7,483	8,091	- 608	2,547	3,307	- 760	14.70
1986	7,409	8,428	- 1,019	2,630	3,575	- 945	14.80
Averages							
69-71	4,625	4,128	496	2,017	1,483	534	11.80
74-76	5,443	5,165	278	2,061	1,865	196	12.97
79-81	6,198	7,033	- 835	2,242	3,067	- 824	15.03
84-86	7,327	8,115	- 788	2,461	3,418	- 957	14.67
Percentage change							
75-70	17.69	25.11	- 44.06	2.18	25.71	- 63.21	9.89
80-75	13.88	36.17	- 400.72	8.80	64.46	-519.86	15.94
85-80	18.21	15.38	- 5.59	9.75	11.47	16.13	- 2.44

Per capita consumption in kg.

Source: Prepared by GEPLACEA, with figures from the International Sugar Organization
Ref.: Bibliography No. 3, annex 2.

TABLE VI

OCEANIA

SUGAR STATISTICS

1,000 MTRV

Year	Pro-duction	Con-sumption	Prod. - Cons.	Export	Import	Exp. - Import	Per capita consumption
1969	2,632	917	1,715	1,883	180	1,703	48.00
1970	2,857	950	1,907	2,009	194	1,815	48.40
1971	3,105	965	2,140	2,133	202	1,931	48.60
1972	3,190	935	2,255	2,605	187	2,418	47.80
1973	2,886	982	1,904	2,400	195	2,205	49.60
1974	3,236	1,009	2,227	2,095	217	1,878	49.70
1975	3,214	1,004	2,210	2,231	192	2,039	48.60
1976	3,702	1,013	2,689	2,878	203	2,675	48.40
1977	3,821	1,016	2,805	3,283	220	3,063	47.30
1978	3,336	1,023	2,313	2,299	196	2,103	47.00
1979	3,419	1,042	2,377	2,438	195	2,243	47.20
1980	3,868	1,018	2,850	2,862	231	2,631	45.80
1981	3,999	1,028	2,971	3,398	157	3,241	44.60
1982	4,153	1,026	3,127	2,921	217	2,704	44.30
1983	3,593	996	2,597	2,781	179	2,602	42.00
1984	4,146	993	3,153	2,990	216	2,774	41.60
1985	3,838	1,012	2,826	3,082	188	2,894	41.80
1986	3,976	1,069	2,907	3,048	210	2,838	44.20
Averages							
69-71	2,865	944	1,921	2,008	192	1,816	48.33
74-76	3,384	1,009	2,375	2,401	204	2,197	48.90
79-81	3,762	1,029	2,733	2,899	194	2,705	45.87
84-86	3,987	1,025	2,962	3,040	205	2,835	42.53
Percentage change							
75-70	18.13	6.85	23.67	19.57	6.25	20.98	1.17
80-75	11.17	2.05	15.04	20.74	- 4.74	23.10	- 6.20
85-80	5.97	- 0.45	8.39	4.85	5.32	4.82	- 7.27

Per capita consumption in kg.

Source: Prepared by GEPLACEA, with figures from the International Sugar Organization
Bibliography No. 3, annex 2.

TABLE VII

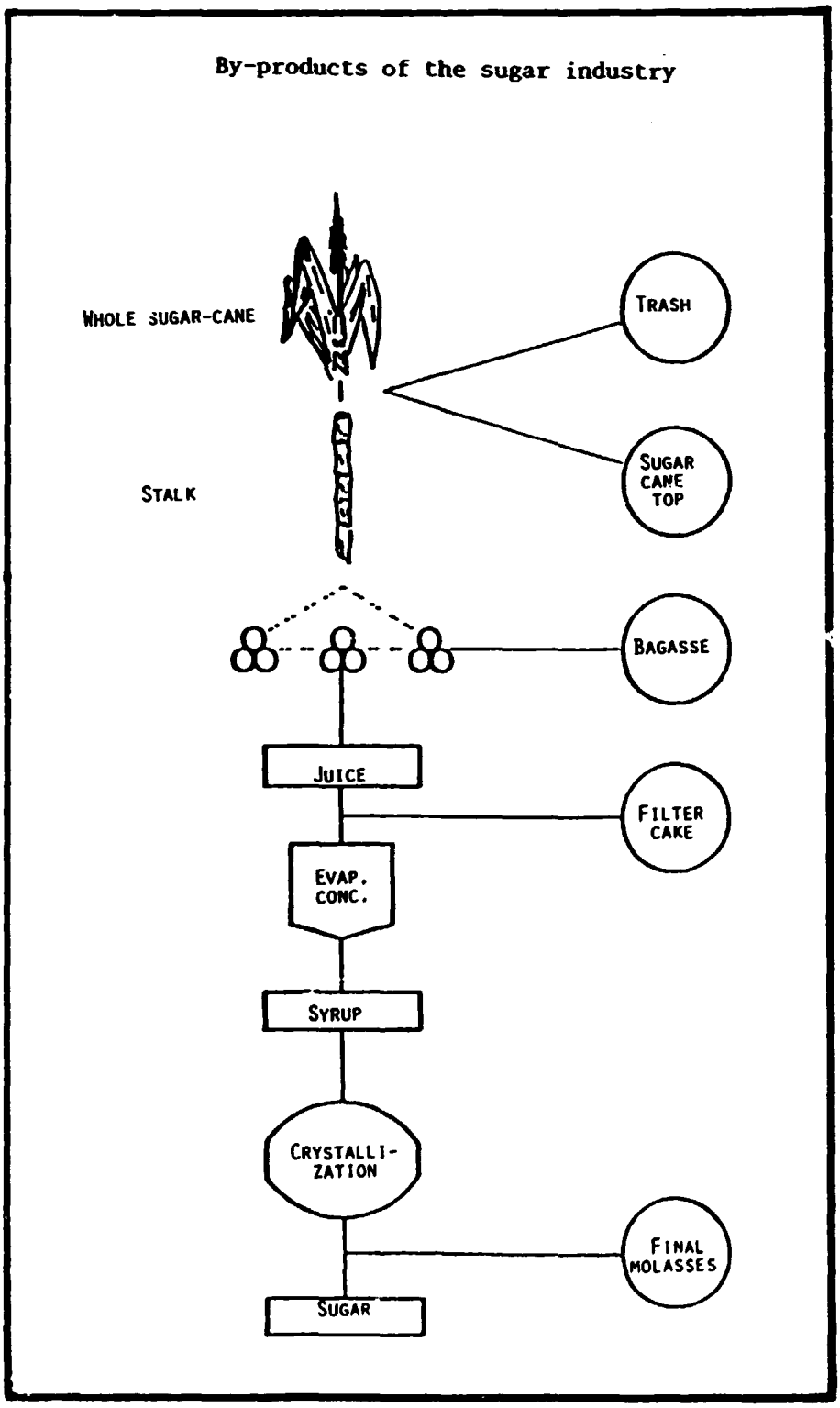
CHANGE IN SUGAR EXPORTS OF COUNTRIES IN LATIN AMERICA AND THE CARIBBEAN, AFRICA, ASIA AND OCEANIA

COUNTRIES	FREE MARKET			TOTAL MARKET		
	1,000 MTRV	$ mill.	$ mill.*	1,000 MTRV	$ mill.	$ mill.*
L.A. & C.						
1974-76	6,821	3,326	3,554	11,176	5,909	6,206
1984-86	6,485	1,268	880	12,325	5,503	3,811
DIFFERENCE	- 336	- 2,058	- 2,674	1,149	- 405	- 2,395
AFRICA						
1974-76	1,418	672	717	2,025	973	1,032
1984-86	1,604	244	168	2,350	543	372
DIFFERENCE	186	- 428	- 549	325	- 430	- 660
ASIA						
1974-76	3,471	1,547	1,636	3,503	1,562	1,652
1984-86	2,716	425	295	2,727	429	297
DIFFERENCE	- 755	- 1,122	- 1,341	- 776	- 1,133	- 1,355
OCEANIA						
1974-76	2,045	874	2,751	2,401	1,066	1,124
1984-86	2,841	373	257	3,028	448	308
DIFFERENCE	795	- 500	- 2,494	627	- 618	- 816
TOTAL						
1974-76	13,755	6,418	8,657	19,104	9,510	10,014
1984-86	13,646	2,310	1,599	20,429	6,924	4,788
DIFFERENCE	- 110	- 4,108	- 7,058	1,325	- 2,587	- 5,226

* Deflated values.

Source: Prepared by GEPLACEA. with figures from the International Sugar Organization
Bibliography No. 3, annex 2.

Figure A

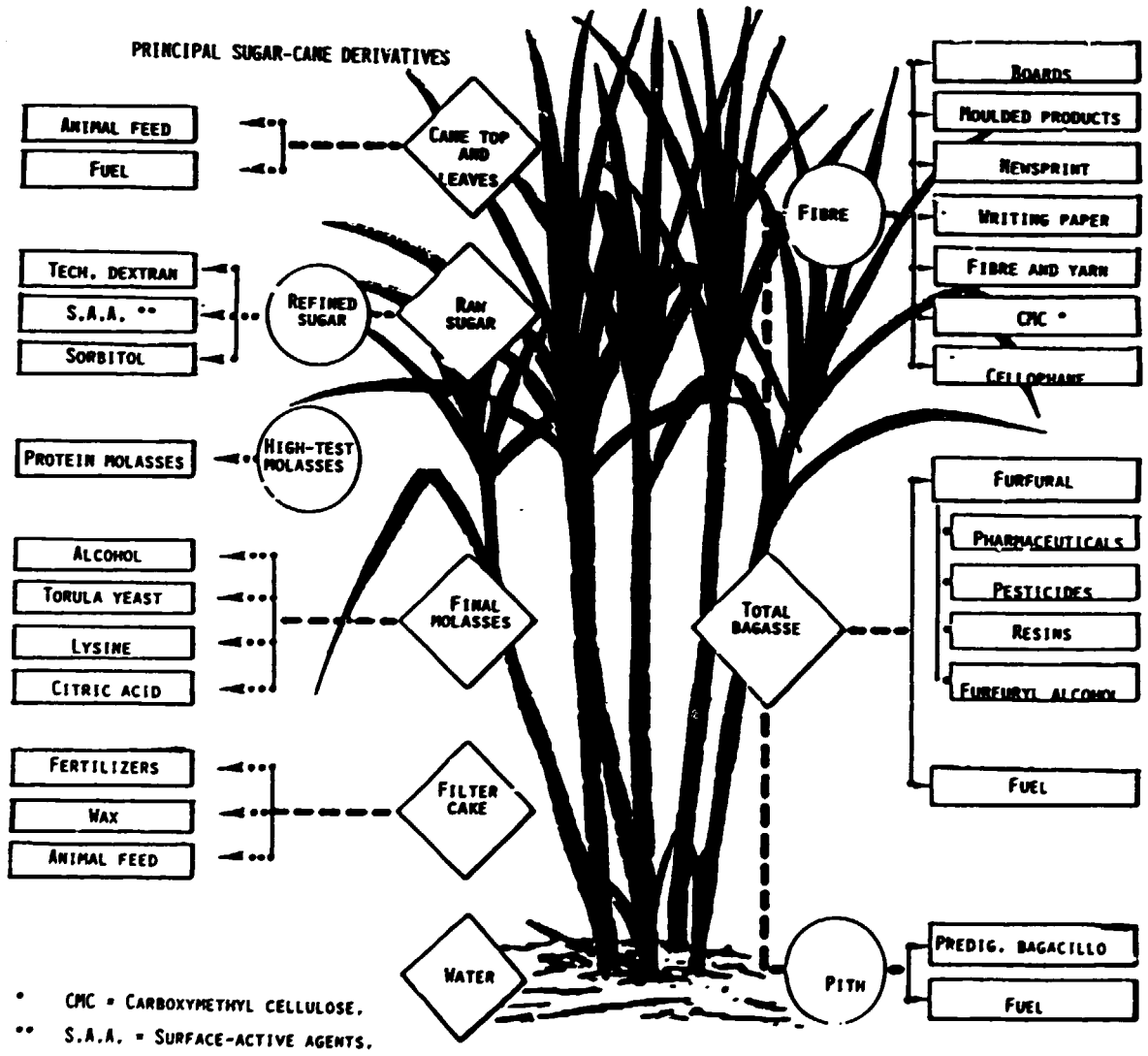


Source: NOA SILVERIO, Herly

Bibliography No. 10b, annex 2

Figure B

By-products and principal derivatives of the cane sugar agro-industry



IDIDCA/Cuba

Source: NOA SILVERIO, Herly

Bibliography No. 10b, annex 2

TABULATION NO. 1

PERCENTAGE COMPOSITION OF SUGAR-CANE

(Approximate)

	Stalk	Cane top and leaves
Sugars	15.43	2.18
Sucrose	(14.1)	
Lignocellulose	12.21	19.08
Ash	0.54	2.31
Fat and wax	0.34	0.77
Nitrogenated compounds	0.48	1.66
Dry matter	29.00	26.00
Water	71.00	74.00
TOTAL	100.00	100.00

(ICIDCA-MINAZ-Cuba. 1985)

Source: NOA SILVERIO, Herly
Bibliography No. 10 b, annex 2.

TABULATION NO. 2

BY-PRODUCTS OBTAINABLE WITH AN

OUTPUT OF 30 MILLION TONS OF SUGAR

BY-PRODUCTS	MILLION TONS
Bagasse, 50% moisture	66
Final molasses, 88° Brix	9
Filter cake, 77% moisture	9
Green leaves	25
Dry leaves	22
Cane top (green stalk)	22

(GEPLACEA 1986)

Source: NOA SILVERIO, Herly
Bibliography No. 10 b, annex 2

Annex 2

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