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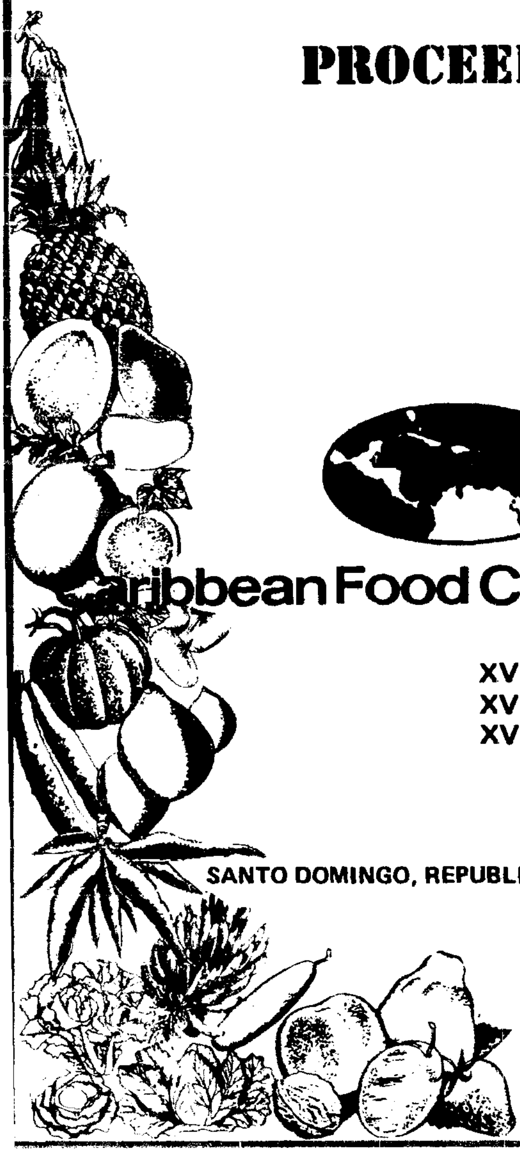

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THE CARIBBEAN ENERGY CRISIS: SUGARCANE VERSUS FOOD CROPS

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INTRODUCCION

The Caribbean Islands have traditionally grown sugarcane as a major export crop for sugar and molasses for over 400 years. Sugarcane has been part of the history, culture, and agriculture of the majority of these Islands since colonial times. Sugarcane plantations, which many times occupied the most fertile farm lands, were given highest priority. Food crops for domestic consumption, especially for the cane laborers, were often grown on small plots close to the laborers living quarters.

Powerful social and economic changes have occurred in the tropical regions were sugarcane had long reigned as "King". In some of the Islands, particulary in Puerto Rico, it has declined from the Island's principal industry and largest employer to a heavily-subsidized, almost bankrupt industry, essentially a government-owned operation. This is due, in great part, to the socio-economic problems involved in mechanizing the sugarcane industry and the depressed price of sugar in the qorld market.

On the other hand, the Islands increasing population, industrial development, and higher living standards have placed increasing pressure on local government to provide food and clothing. With increased mechanization of agriculture, coupled with industrial development and higher living standards, the needs for energy in the Caribbean is also increasing. Energy that is almost totally suppied by imported fossil fuels, primarily petroleum.

There is a solution, either partial or total, to the Caribbean energy problem by using sugarcane, primarily, and other tropical plant as energy sources. More than any other plant, sugarcane has the ability to convert solar energy into a renewable energy source. By using the entire plant (biomass) for both combustible and fermentable solids, sugarcane can provide energy that can be grown by man.

The objective of this paper is to present possible choices in achieving a balance between food and energy production within the limited land resources of the Caribbean Islands.

DISCUSSION

Land and Human Resources

The land resources of the Caribbean Islands are limited, not only in total area of each country, but area available for agriculture. The percent of arable agricultural land (not including permanent pastures) as related to total land area for most of the Caribbean Islands are given in table 1. The highest percent of total area for cultivated crops is 77% found in the rather flat island, topographically, Barbados. The lowest, 8% , is found in the very mountainous island of Martinique. What many people forget, is that the majority of the Caribbean Islands, geologically speaking, are part of a mountain chain. Thus, the amount of flat to rolling land suitable for cultivated agriculture is limited.

The human resources are plentiful. In fact, related to land area, the Caribbean Islands have a high population density. Barbados, with about 6 persons per hectare (ha) of total island area (table 2) has one of the highest population densities in the world. The lowest population densities are found in Cuba and the Dominican Republic.

In relation to amount of cultivated land available, the population density becomes even more aggrevated. As shown in table 2, the cultivated agricultural lands must support a large number of personas, with the highest 43 people per ha in Martinique to a low of 4 in Cuba. Once again, the steep topography of many of the Caribbean Islands diminish the lands available for cultivated food crops and increase the number fo people to be feed per unit of arable land.

The way of life has changed in the Islands, as the standard of living has increased. Electricity, radio, television, motor transportation have become daily necessities for many of the population. Cities and towns have grown large, and commerce and manufacturing have replaced a good part of the agrarian style of living. These changes demand more energy usage in the daily life of the people.

Food Crops

No island in the Caribbean can boast of complete domestic production of its entire food supply. Some of the countries with larger land areas, such as Cuba and The Dominican Republic are much les dependent on food imports than say, Puerto Rico. Changes in life style and eating habits have prevailed. Such items as wheat flour, white potatoes and beef have become import items to many of the Island.

Including sugar, most Islands have historically depended on food crop exports for a favorable trade balance. In the majority of the Islands, the better agricultural lands (level topography, water availability and good drainage) have been devoted to sugarcane and such export crops as bananas and pineapples. One of the exceptions has been the Dominican Republic which has many of its food crops growing on rich alluvial coastal soils and fertile valleys.

TABLE 1.
LAND RESOURCES OF THE CARIBBEAN ISLANDS 1/

Country	Area, ha x 1000		%arable	Sugarcane	
	Total	Arable	of total	Area, ha x 10000	%of arable
Barbados	43	33	77	16	48
Cuba	11,452	2450	21	1150	47
Dominican Republic	4,873	435	9	160	37
Guadeloupe	178	48	27	25	52
Haiti	2,775	530	19	75	14
Jamaica	1,099	200	18	65	33
Martinique	110	9	8	5	56
Puerto Rico	890	169	19	51	14
St. Kitts	27	8	30	4	50
Trinidad	513	70	14	34	49

1/ Derived in part from data, Anonymous (1976)

TABLE 2
HUMAN RESOURCES OF THE CARIBBEAN ISLANDS 1/

Country	Population x 1000	Population density per ha	
		Total area	Arable land
Barbados	251	6	8
Cuba	9,876	1	4
Dominicana Republic	5,206	1	12
Guadeloupe	375	2	8
Haiti	4,844	2	9
Jamaica	2,140	2	11
Martinique	383	3	43
Puerto Rico	3,468	4	21
St. Kitts	68	3	9
Trinidad	1,053	2	15

1/ Derived in parr from data, Amonyrnous (1979).

Limited area prevents further food crop expansion either from a lack of land itself, or because new lands have severe limiting factors such as lack of available water, excess salimity, topography, and shallowness of the soil profile. Increasing population will demand more more domestic production from the lands already in food proauction.

Sugarcane Energy Crop

Sugarcane must be reevaluated as an energy crop where total biomass (stalk, tops, and leaves) rather than sucrose is the prime consideration. As a food crop, sugarcane offers small economic potential. The domestic consumption of sugar can be eaisly met with small acreages. As an export crop of sugar and molasses, its potential is limited by reduced world prices and excess of production. However, as an energy crop, its potential economically is large.

Sugarcane total biomass when processed consists of combustible organic material and fermentable solids. A MT of millable cane plus its 299 kgs of tops and leaves contains on the average 160 kgs of fermentable solids and 121 kgs of combustible solids. (A short ton of sugarcane plus its 600 lbs of tops and dry leaves contains 319 lbs fermentable solids and 245 lbs of combustible solids.)

The combustible organics consists mainly of the fiber from the cane stalk, tops, and leaves. When ground, this fiber is called bagasse. A metric to (MT) of bagasse (6% dry weight) has an energy content of 4.16 million calories which has an electrical eqivalent of 17.4 billion joules or a fuel value equivalent to 455 liter of oil. (A short ton of dry bagasse (6% moisture) has an energy content of 15 million BTU's which has an electrical equivalent of 1,500 KWH or a fuel value equivalent to 2.6 barrls of oil.

At present in many Islands, the average cane yield is about 16 MT per ha (27 tons per acre) plus 30% more for cane tops and dried leaves gives 79 TM per ha (35 tons per acre) or 20 dry MT per ha (9 tons per acre) in a 12-month crop. Production of 135 MT per ha (60 tons per acre) green cane per year are not uncommon when adequate water and fertilizer are available. Incidentally, at the present time, in many Islands, the cane tops and trash are burnt before cutting the cane as a means of easing haverst operations. This amounts to 4.5 MT per ha (2 tons per acre) of dry trash which is equivalent to 78.3 millon joules or 2,048 liters of oil per ha (3,000 KWH or 5.2 barrels of oil per acre) being sent up in flames.

Alexander (1978) working with sugarcane biomass in Puerto Rico has obtained a 3-fold increase over the average tonnage for the Island's sugar industry in initial attempts to maximize tonnage. The increases resulted from such changes in management practices as selection of high-tomnage varieties, increased fertilization, use of narrow row centers, and inclusion of trash (tops and leaves) in the final tonnage calculations.

The fermentable solids are usually made into sugar plus molassses remaining. The molasses is sually fermented into alcohol yielding 0.37 liter of alcohol (ethanol) from 1 liter of molassses (0.37 gallons of alcohol from 1 gallon of molasses). However, we can ferment the cane juice directly without producing sugar or molasses and obtain 65 liters of alcohol per MT of cane (15.6 gallons per ton of cane).

It would be unfair to conclude that all of the Islands can readily triple their present cane tonnage per unit area, The increassing of sugarcane biomass per unit area is based on needed imputs such as adequate available wat er, appropriate varieties, closer spacing, and elimination of marginal cane lands. Table 3 indicates the potential electrical power that can be produced from bagasse in the Islands assuming the present cane tpnnage production can be doubled per ha by using the basic biomass agronomics. It should be remembered that a part of the electrical energy produced will be used to grind the cane. The portion used for grinding will vary with such factors as mill desing and efficiency and varieties. In many cases, it should be about 50% . When we consi- derthat 1 barrel of oil produces 577 KWH, oven at 50% usage for milling the cane, the other 50% would produce saving amounting to about a 0.3 million barrels of oil for Martinique or St. Kitts if the burned bagasse instead of oil to produce electrical energy. For such larger sugar producers as Cuba and the Dominican Republic, it would be savings of approximately 55 million and 11 million barrels of oil, respectively.

When we consider converting the fermentable solids into an energy fuel, we have more choices. A certain amount of the fermentable solids can be made into sugar, molassses, and alcohol. But if world prices of sugar are low, the cane juice can go directly to alcohol. If you consider adding the alcohol to gasoline, as is being done in Brazil and the United States, great savings can be realized in the importation of gasoline. The gasahol mixtures of up to 20% alcohol 80% gasoline do not requiere any major modification of the car motor. The gashol produces more mileage and less air contamination than gasoline alone. If we should use 10% gasahol mixture (1 part alcohol 9 parts gasoline), the Dominican Republic, for example, could use 242 million liters (64 million gallons) less gasoline per year if the alcohol was made from molasses, or 1,713 million liters (453 gallons) of gasoline if the alcohol was derived from the cane juice (table 3).

An asset from the sugarcane biomas energy program is the residual of filter-press cake or mud from the mill and the stillage or vinasse from the distillery which has values as a fertilizer (Samuels, June 1979). Filter-press cake, a dark-brown organic material contains on a dry-weight basis about 40% organic matter, 2.2% N, 2.8% P_2O_5, 0.4% K_2O and 3.1% CaO. Stillage, a brown liquid, contains, per 1,000 gallons 530 lbs of organic matter, 10 lbs. N, 1 P_2O_5, 65 K20 and 30 CaO if derived from molasses.

Apart from sugarcane, other energy crops, such as sweet sorghum and tropical grasses are available to supplement sugarcane for short-term crops of 2 to 6 months or on lands not suitable for cane (Alexander). The use of these other sources would allow the mills to grind all year round to supply electrical energy as well as sugar and alcohol on the normal grinding season.

Sugarcane: Possible Food and Energy Crop Rotaions

Agricultural planners must weigh carefully the merits of energy planting for the available land resources. One extreme would be to plant as much of the available agricultural land in food crops to keep up with population increases and diminish imports.

TABLE 3.
CANE TONNAGES AND PROJECTED POSSIBLE ENERGY PRODUCTION AVAILABLE FROM SUGARCANE PRODUCED IN THE CARIBBEAN INSLADS 1/

Country	Millable cane 2/	Possible energy production		
	MT x 1000 Ton x 1000	Electrical 3/ KWH x billion	Molasses	Alcohol Gane juice
			Liters x million (Gallons x million)	
Barbados	975 (1,073)	1.1	23 (6)	163 (43)
Cuba	51,000 (56,100)	54.8	1,207 (321)	8,546 (2,258)
Dominican Republic	10,246 (11,271)	11.0	242 (64)	1,713 (453)
Guadeloupe	1,200 (1,320)	1.3	28 (8)	198 (52)
Haiti	2,969 (3,266	3.2	7 (2)	50 (13)
Jamaica	4,000 (4,400)	4.3	95 (25)	673 (178)
Martinique	310 (341)	0.3	1 (,2)	7 (2)
Puerto Rico	3,300 (3,630)	3.5	78 (21)	552 (146)
St. Kitts	326 (359)	0.3	1 (.2)	7 (2)
Trinidad	2,285 (2,514)	2.5	54 (12)	382 (101)

1/ Projections are based on an assumption of doubling millable cane production by use of biomass agronomics.

2/ Taken from Anonymous (1976) for 1975 crop year.

3/ Based on dry biomass cane (stalk tops trash producing 1,650 KWH per MT or 1,500 KWH per short ton.

Self-sufficiency in food production might be attained, but rising energy costs would bring economic ruin. The other extreme would be to devote all the cultivated agricultural lands to energy cropping of sugarcane. The steeper lands, pastures, and marginal lands would be used for food crops. In the larger Islands, it would almost be sufficient to supply the energy needs. For the smaller Islands, the acreage may not be enough. The author has calculated that for Puerto Rico, the 109,312 ha (270,000 acres) mechanizable land could supply about two thirds of the Island's energy requirements using sugarcane biomass (Samuels, March 1979). Imports for food would cost less than the oil imports giving a more favorable trade balance.

The decision of how much land to devote to sugarcane energy crops will vary with the various Islands of the Caribbean, each having their own economic, agronomic, social, and political requirements. In islands such as Cuba and the Dominicana Republic, larger areas of agricultural land (table 1) and lower population densities (table 2) make the possibility of simultaneous energy and food cropping appear more feasible than for the Islands with small land area. Trinidad with its own petroleum sources may not have inmediate need for energy cropping. However, oil is not replenishable, and when it runs out, Trinidad will need to depend on the renewable energy source: sugarcane-biomass farming. Barbados, with its high percent of arable area in cane, has given attention to food crops by legislation which places a minimun percentage of food crops that must be grown in sugarcane lands.

Another important item to remember is that sugarcane biomass cropping will not cause farm labor unemployment. It will require about the same labor force as for regular sugarcane growing. One benefit will be the possible employment of a labor force for 12 months of the year. Pilot-plant projects proposed for Puerto Rico will make use of the mill all year around, grinding cane for about 8 months and burning stored bagasse and dried tropical grasses for the other 4 months.

It should be remembered that the facilities needed for converting bagasse to electrical energy are available in every sugar mill. In the Dominicana Republic, the Rio Haina mill has been making available about 50%of its electrical production for use by the nearby capital, Santo Domingo. Alcohol distilleries are quite common in the Caribbean Islands being used to produce rum from molasses. Expansion fo these facilities to make alcohol for gasahol is feasible until new facilities are buit.

CONCLUSION

The Caribbean Islands are dependent on imported fuel sources for their major energy needs. Rising oil prices are causing severe imbalances in the Island's economy. Food crops demands are increasing to kepp up with expanding population and reduced food imports. Sugarcane as a fuel crop can be grown to produce energy for electricity or motor fuel. The change to a sugarcane biomass energy cropping program from normal sugarcane cropping for sugar production is not too difficult nor uneconomical. The major problem is the limited acreage of suitable agricultural land in the Caribbean Islands to allow for both food and energy cropping. The stage is now set where agricultural planners must use great care in their choice as to food and/or fuel cropping for their Island.

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