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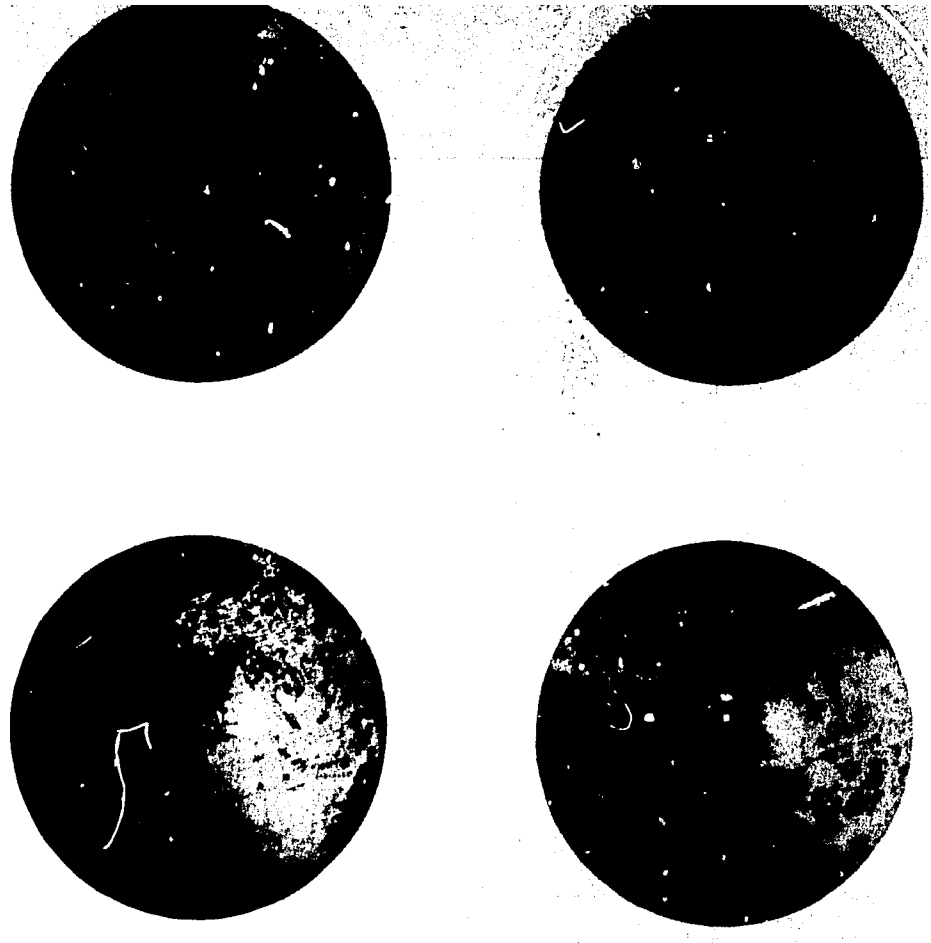

ECONOMIC FEASIBILITY OF IMPORT SUBSTITUTION OF LIVESTOCK FEED IN THE CARIBBEAN COMMUNITY

Clifton F. Charles, David Blandford, and Richard N. Boisvert

DEPARTMENT OF AGRICULTURAL ECONOMICS
New York State College of Agriculture and Life Sciences
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July 1980

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ABSTRACT

This study evaluates the economic feasibility of substituting domestically-produced corn and soya for imports in the Caribbean Community (CARICOM), with special emphasis given to the availability of land suitable for their production, domestic production costs relative to import costs, and the implications for employment and the balance of payments.

Two major conclusions are derived. First, if a corn/soya industry had existed in 1975 under the cost conditions assumed, it could have potentially reduced both corn and soya meal imports by about 45 percent, and soya oil imports by over 30 percent. Second, land and labor resources within the Community are adequate to achieve self-sufficiency in either feed or oil, but not both. The implications of self-sufficiency for resource use and foreign exchange differ significantly among countries. Some countries within the Community would realize increases in employment, while others would experience a reduction, even if labor-intensive production methods were adopted. Although the Community's overall foreign exchange position improves, the position of some countries improves at the expense of others.

Superficially, it appears that quotas, required only in Guyana and Jamaica, provide the simplest means to achieve import substitution. However, quotas are viewed unfavorably by the international community. Prohibitive tariffs provide a theoretical alternative, but the rates required would generally be over 50 percent and would differ between member countries. Because CARICOM has been attempting to harmonize its tariffs and adopt a common external tariff, harmonization on the maximum rate needed to ensure self-sufficiency could result in excessive protection in some of the member countries.

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ECONOMIC FEASIBILITY OF IMPORT SUBSTITUTION OF LIVESTOCK FEED IN THE CARIBBEAN COMMUNITY

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1. INTRODUCTION

Import substitution may be defined as the replacement of imported goods by the same or similar goods produced domestically (Ahmad). In the past, it has attracted attention primarily as a means of promoting industrial development in less-developed countries (LDC's). Due to a number of economic and political factors, recent emphasis has shifted from manufactured products to agricultural commodities (Sisler and Blandford).

As income and population have increased, many poorer countries have experienced substantial growth in agricultural imports, particularly grains. In 1970, LDC's spent $2.3 billion on imports of the principal grains (rice, sorghum, maize, and wheat); by 1976, this had more than tripled (IBRD).1/ Imports of oilseeds and meals rose from $0.43 billion to $1.49 billion; coupled with the escalating cost of petroleum, they have contributed to a growing balance of payments deficit in many countries. To cope with the problem, agricultural import substitution is viewed as an appropriate objective by LDC's. It is believed to be more realistic in the short-run than the reduction of oil imports, and is reinforced by the fact that LDC's are vulnerable to outside political pressures if they depend on imported food.

Another policy development has been the formation of customs unions and free trade areas to promote trade between LDC's (Baldwin and Kay). Advocates have pointed to the success of the European Community in stimulating economic growth. By acting independently, a single LDC is unlikely to have the necessary resources to develop a number of sectors

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1/ All values in this report are in U.S. dollars.

simultaneously. The traditional benefits of specialization are made more appealing by the possibility of "more equitable" trading relationships between nations at similar levels of economic development.

The Caribbean Community (CARICOM) provides a prime example of the coalescence of these two themes in LDC trade policy. CARICOM, a customs union of twelve Caribbean countries, stretching from Belize on the Caribbean coast of Central America, to Guyana on the South American continent (figure 1.1), is the successor to the Caribbean Free Trade Association (CARIFTA), formed in 1968.

The Community has a total land area of approximately 100,000 square miles and a population of 4.6 million in 1970. The two largest countries, Guyana and Belize, have 92 percent of the total land mass of the Community, but only 12 percent of the total population. Barbados, Guyana, Jamaica, and Trinidad and Tobago, which collectively accounted for 93 percent of the Community's population in 1970, also accounted for 87 percent of its Gross Domestic Product (GDP). Per capita GDP of this group of countries in 1970 was roughly $600, while that of the other eight countries averaged $300. For this reason, it is convenient to classify the former group as the more-developed CARICOM countries (MDCC's), and the latter as the less-developed CARICOM countries (LDCC's).1/

In common with many other developing regions, food consumption, particularly the consumption of meat and livestock products, has been growing rapidly in CARICOM. In 1975, Shillingford and Blades determined that the demand for meat and livestock would probably increase at a rate of almost 6 percent per annum during the 1970's--roughly double the rate of increase for traditional staples such as corn and pulses. As a result of the growing demand for meat and livestock products, imports of animal feed by the Community's livestock industry have been increasing. As table 1.1 demonstrates, imports of corn and oilseed cake and meal (primarily soya meal) by the MDCC's more than quadrupled in value between 1970 and 1978. This places increased demands on the supply of foreign exchange. It is also inconsistent with the Community's stated objectives of promoting inter-regional trade and regional integration (CARICOM, Secretariat).

In response to the problem, the Community established a "Food Working Party" in the early 1970's to develop a plan to increase domestic food and feed production. In 1976, the Working Party founded a Food Corporation, with an authorized share capital of $50 million, to promote domestic food projects. As a result, experimental feed grain production schemes have been established in Belize, Guyana, Jamaica, and Trinidad and Tobago to evaluate the technical feasibility of producing corn and soya in the Region. However, little attention has been given to the total production potential of the Region.

1/ This distinction is purely relative. All the countries involved are less-developed when compared to industrialized countries.

FIGURE I.I. THE CARIBBEAN COMMUNITY (CARICOM)

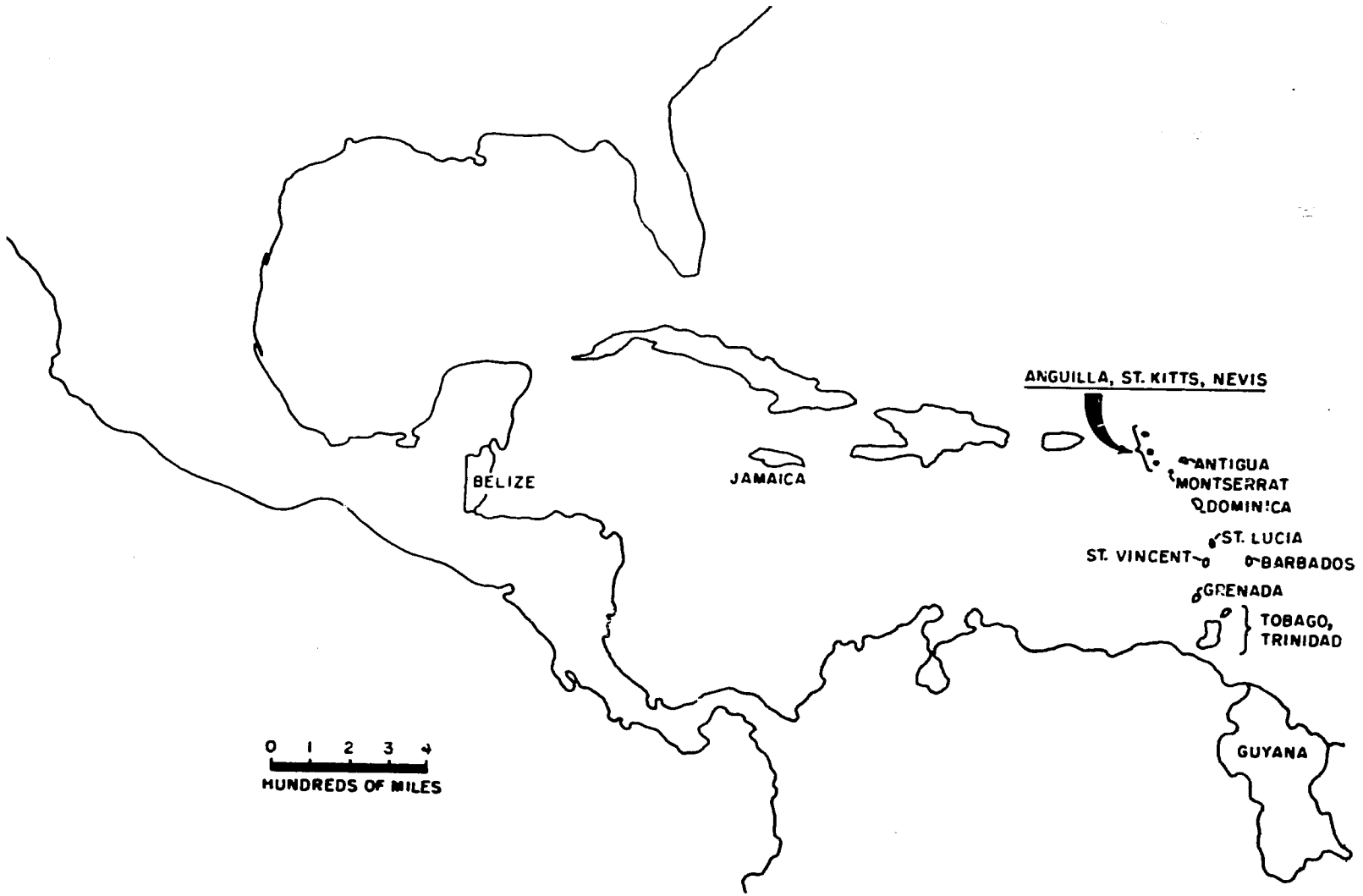

Table 1.1 Imports of Principal Livestock Feeds by the Four MDCC's[a/]

	Corn	Oilseed Cake and Meal	Total
	----------	$ million	----------
1970	9.0	2.8	11.8
1971	10.5	2.3	12.8
1972	12.7	4.6	17.3
1973	16.2	5.3	21.5
1974	29.2	7.2	36.4
1975	35.7	7.4	43.1
1976	37.9	12.7	50.6
1977	32.1	16.8	48.9
1978	35.3	13.6	48.9

Source: United Nations, Food and Agriculture Organization, Trade Yearbook, various issues.

a/ The MDCC's or more-developed CARICOM countries are Barbados, Guyana, Jamaica, and Trinidad and Tobago.

This study is designed to evaluate the economic feasibility of substituting domestically-produced corn and soya for imports, given the availability of land suitable for their production. Emphasis is given to domestic production costs relative to import costs, and to the implications of import substitution for employment and the balance of payments. The effectiveness of alternative trade policy instruments (tariffs and quotas) for achieving import substitution objectives is evaluated.

2. BACKGROUND ON IMPORT SUBSTITUTION IN CARICOM

The treaty which created CARICOM was designed to facilitate regional integration. It stressed coordination and regulation of economic and trade relations, and the promotion of regional economic independence. Article 49 of the Treaty provides for the rationalization of agriculture, the achievement of optimal resource allocation, and the replacement of imports on a regional basis (CARICOM Secretariat). In order to understand this emphasis on import substitution, it is necessary to consider the balance of payments position, the composition of exports, and the structure of agriculture within the Region.

2.1 Balance of Payments and Export Composition

Because the four MDCC's (Barbados, Guyana, Jamaica, Trinidad and Tobago) account for such a large proportion of the Community's

population and income, their balance of payments position and export composition are of fundamental importance. As table 2.1 indicates, both Jamaica and Barbados have tended to have a deficit in their merchandise trade balance. Both of these countries rely fairly heavily on exports of primary commodities--bauxite/alumina and sugar in the case of Jamaica, and sugar in the case of Barbados (table 2.2). In the early 1970's, Trinidad and Tobago had a balance of payments deficit, but a reversal of its position has coincided with the increase in the price of petroleum since 1973-74. Trinidad's exports are totally dominated by petroleum, with sugar the only other export of any significance (table 2.2). Guyana has had a mixture of annual surpluses and deficits in its merchandise trade balance. Averaged over the period 1970-78, there was a slight surplus. As in the other MDCC's, primary commodities, particularly bauxite/alumina and sugar, totally dominate Guyana's exports.

Table 2.1 Balance of International Transactions for the Four MDCC's

Year	Surplus of Exports over Imports			
	Guyana	Trinidad & Tobago	Jamaica	Barbados
	- - - - - - - - - - - - $ million - - - - - - - - - - - -			
1970	9.1	6.2	-107.6	- 71.0
1971	25.4	- 77.2	-131.1	- 78.5
1972	12.5	- 89.4	-128.8	- 76.6
1973	-16.7	1.5	-125.5	- 73.6
1974	27.5	346.3	- 40.9	- 81.7
1975	30.9	361.6	-109.2	- 69.5
1976	-38.5	391.2	- 98.9	-107.4
1977	-20.0	516.8	68.6	-116.9
1978	26.8	302.9	14.1	-116.5
Average, 1970-78	6.3	195.5	- 73.2	- 88.0

Source: International Monetary Fund, Balance of Payments Yearbook and International Financial Statistics, 1980.

Note: Merchandise trade balance in SDR's, converted to dollars by using average annual $/SDR exchange rate.

For two of the MDCC's, Barbados and Jamaica, persistent balance of trade deficits make import substitution attractive. For the other two MDCC's, reliance on exports of non-renewable natural resources (bauxite/alumina and petroleum), and agricultural commodities, whose markets have traditionally been unstable, make import substitution also an attractive proposition.

Table 2.2 Major Contributors to Export Earnings of the Four MDCC's

Year	Contribution to Export Earnings							
	Guyana			Trinidad & Tobago		Jamaica		Barbados
	Bauxite & Alumina	Sugar	Rice	Petroleum	Sugar	Bauxite & Alumina	Sugar	Sugar
	percent							
1970	51	28	6	77	5	75	12	37
1971	48	27	7	77	4	64	11	33
1972	43	34	8	78	6	63	11	32
1973	46	30	9	81	4	64	10	31
1974	33	48	8	86	3	69	12	30
1975	32	50	10	88	4	61	19	44
1976	42	34	10	91	2	63	10	27
1977	49	28	10	92	2	73	10	25
1978	37	35	13	90	1	77	9	18
Average 1970-78	42	34	9	84	3	68	12	31

Source: International Monetary Fund, International Financial Statistics, 1980.

2.2 Structure of Agriculture

Two aspects of the structure of agriculture in the Region are particularly significant: the role of the sugar industry; and the potential for the development of a livestock feed industry.

2.2.1 The Sugar Industry

The Caribbean sugar situation is important because of the potential competition between sugar and feed grains for land in the two MDCC's with the greatest demand for feed, namely, Jamaica and Trinidad and Tobago. In 1973, the total investment in sugar estates and factories in the Region was over $200 million. Sugar cane occupied approximately 500,000 acres of the Region's arable land, and both directly and indirectly provided employment for approximately 500,000 persons, or 11 percent of its population (Girwar). Sugar is a major export commodity (table 2.2) and occupies the largest amount of arable land devoted to any single crop in the Region. In most countries, the sugar industry is also the largest single employer. Thus, it is impossible to consider agricultural change without considering the implications for the sugar industry, particularly if such change implies an alternative use for land that is presently in sugar production.

From an ecological standpoint, sugar cane is ideally suited to the Region (Hagelberg), but the high level of trade protection has been the most important factor in the survival of the industry. Caribbean

exporters benefited from preferential pricing arrangements in their exports to Britain under the Commonwealth Sugar Agreement. Since Britain entered the European Community (EC) in 1973, it has become clear that the protected market which CARICOM's sugar industry has enjoyed would not persist indefinitely.

Under the 1975-1980 Common Agricultural Policy for sugar, all EC members except Italy received increases in production quotas. Prices were raised to levels which make sugar beets competitive with other crops. As a result, the EC will probably be producing substantial surpluses of sugar in the 1980's. When this is considered in conjunction with the EC's commitment to provide a guaranteed market for 1.3 million metric tons of raw sugar from African, Caribbean, and Pacific (ACP) countries, it seems certain that the EC will soon be placing more than 1.3 million metric tons of surplus sugar on the world market (USDA).

There is also cause for concern over the future impact of the EC's preferential pricing arrangements. Although existing prices appear to be more favorable than those of the Commonwealth Agreement, there is evidence that costs of production in the Caribbean sugar industries are rising much faster than costs in the EC. Thus, the competitive position of the Caribbean countries can be expected to deteriorate. Conflicts have already appeared in price negotiations with the European Community. In 1976, the ACP countries requested an 8 percent increase in price, whereas the increase for EC members was only 1 percent. Similarly, in 1977 when the EC offered a 2 percent price increase, the ACP countries claimed that their costs of production had risen by 16 percent (McGregor).

In the U.S., another important market for Caribbean sugar, High Fructose Corn Sweetener (HFCS) is beginning to account for a larger share of the market for sweeteners. The threat posed by HFCS is that the U.S. is a large producer of corn, and that HFCS becomes competitive with cane sugar at prices exceeding 12 to 14 cents per pound. (Production costs for cane sugar in the MDCC's in 1975 ranged from 10.6 to 15.6 cents per pound (USDA).) There is also the continual threat that U.S. sugar growers will be granted greater protection against sugar imports, and that CARICOM sugar will lose its preferential treatment in the Canadian market.

Although the aim of the new International Sugar Agreement, which became effective January 1978, is to keep prices within the range of 11 to 21 cents per pound, the world market for sugar continues to be notoriously unpredictable. Relatively small variations in world production can lead to large changes in prices. Since 1970, world raw sugar prices (annual averages) have varied between 8 cents and 65 cents per pound (IBRD).

The rapidly rising costs of sugar production in CARICOM countries have already created difficulties in the Region. Both government and private investments are limited to mechanization of the sugar industries. In general, no significant increase in capacity is planned. Labor

shortages in some areas, coupled with union resistance to mechanization in others, work against the competitive position of the industry.

Because of both poor market prospects and a deteriorating competitive position, authorities are divided over the issue of continuing in sugar or replacing it with other activities. All countries agree that in order for the sugar industry to survive, drastic structural transformation will be required (Girwar). This opens the way for import substitution of feed grains, utilizing land resources which for centuries have been dominated by sugar.

2.2.2 The Livestock-Feed Industry

The livestock-feed industries in CARICOM are closely linked to changes in livestock production. During the period 1961-70, livestock numbers increased, with the exception of cattle and goats (Liverpool). The greatest increase was in poultry, which expanded by 600 percent. Pig and sheep numbers increased by 23 percent and 16 percent, respectively.

Jamaica, and Trinidad and Tobago are pursuing expansion programs in beef and dairy. Intensive beef production is most advanced in Jamaica, where beef feedlot operations have been expanded since 1964. Pasture is relatively limited, and although it is cheaper per animal to fatten on grass, greater throughput makes the feedlot a more profitable operation, particularly on farms of over 500 acres. The development of the beef industry in Jamaica is, therefore, linked to the availability of concentrate feeds.

Jamaica is expected to expand milk production from 10.5 million imperial gallons in 1974 to 19 million gallons in 1980. It also expects to expand beef production during the same period from 28 million to 36 million pounds (Jamaica, Ministry of Agriculture). Trinidad and Tobago aimed to expand its milk production 19 percent between 1972 and 1980, and its beef production by 48 percent. The targets for pork and mutton production over the same period represent increases of 182 percent and 785 percent, respectively (Government of Trinidad and Tobago).

In all countries in which the dairy industry is being developed, imported concentrate feed (primarily corn and soya) is the basis of the industry, and constitutes approximately 60 percent of the cost of milk production. When it is also considered that poultry and pork owe more than 70 percent of their values to imported concentrate feed, the dependence of the Region on corn and soya is striking.

The principal reason why corn/soya imports are so significant is the limited availability of domestic feedstuffs. A feed grain industry only exists in the Region in the experimental or commercial trial stage, and current sources of domestic feed are limited to pasture, root crops, copra meal, and sugar cane. Import substitution for corn and soya should be evaluated in conjunction with the potential contribution that these alternative sources might make to meeting a larger proportion of CARICOM's demand for feed.

Pasture

The bulk of the available pasture land in the Region is located in Guyana. Osuji has estimated that in order to satisfy effective CARICOM meat demand in 1975 more than 12 times the present cattle population would be needed. If pasture alone were utilized, 6 million acres of land in Guyana (12 percent of the total land area) would be required, and Guyana would have to produce almost 85 percent of the total beef output of the Region. This would require tremendous capital investment and a solution to animal health problems. It is unlikely that CARICOM could satisfy its meat requirements by raising cattle on intensively managed pastures.

Root Crops and Copra

Although root crops, especially cassava, are important sources of energy in livestock feed in Europe, CARICOM's demand for cassava for human consumption in 1975 far exceeded domestic production (Osuji). Due to the labor-intensive nature of cassava production, and the relatively high cost of labor, its cost as an animal feed may be prohibitive. Because copra production is declining, little is available as protein feed.

Sugar Cane, and Its By-Products

In Barbados, development of the beef industry could depend on by-products of cane and sugar. Sugar cane tops have been recognized as a potential source of roughage for cattle, particularly in the dry season. The nutritional value of the feed could be enhanced through the addition of protein. Beef steers have shown superior performance on a diet of cane tops and a urea/molasses/vitamin mixture as opposed to cane tops alone. In fattening cattle, as much as 45 percent of the grain mixture can be replaced by molasses (Mayers). However, suitable technology for utilizing molasses in feed in the Region still must be developed.

In Barbados, Comfith-CT, a combination of the pith of the cane and the cane tops is used as feed for beef cattle (Mayers). Output of 32 tons per acre is adequate for feeding five beef animals, or for the production of 3,000 pounds of beef at a rate of approximately 2 pounds per day. While it has to be supplemented by protein, minerals, and vitamins, it does not depend on the production of refined sugar, and has the advantage of producing a uniform supply of digestible energy throughout the year. However, it is difficult to transport, and thus requires the integration of beef and sugar cane production.

The greatest potential appears to lie in cane feed, which is composed of chopped cane stalks and leaves mixed with prescribed supplements. It is primarily intended for feedlot beef production, although its application to dairy cattle is probable in the future. The average cost of cane feed in 1975 was $21.60 per ton, based on in-company

production costs for sugar cane ranging from $6.90 to $11.30 per ton in the MDCC's. The effective feedlot price in 1975 was 25 cents per pound of weight gained. This compared favorably with other intensive commercial feeding systems, and with an average of 29 cents for other forage-based feeds (Lambie & Company).

Cane feed has the advantage of low direct import content, less than 20 percent compared with 85 percent for other commercial feeds. Its major disadvantage is that it must be served fresh, and requires careful preparation. Like Comfith-CT, it requires the integration of beef and sugar cane production. Despite these drawbacks, four cane feed beef projects, with an estimated investment of $3.3 million, have been established in Belize, St. Vincent, Nevis, and St. Lucia.

Feed Grains

As in the case of cane-based feeds, the development of feed grain (corn and soya) production is in an experimental stage. Projects exist in Guyana, Trinidad and Tobago, Jamaica, and Belize, with some experimental work on a smaller scale in Barbados. In 1974, a total of 500 acres of soybeans was grown in Guyana with yields averaging 1,500 lbs. per acre. There is also a regional corn/soya project of 10,000 acres. The expected average yield of corn on this project is 2,500 lbs. per acre.

In Trinidad and Tobago, commercial production of these crops (and also sorghum which has not proven to be as successful), is associated with a Pilot Commercial Farm operated jointly by the German, and Trinidad and Tobago governments. On this farm, soya yields in excess of 2,000 lbs. per acre have been achieved. Yields of 1,700 lbs. of soybeans per acre and 4,000 lbs. of corn are expected in Trinidad. In Jamaica, the equivalent expected yields are 1,500 lbs. per acre and 3,500 lbs. per acre, respectively. Estimates of costs and resource requirements have been derived from these experimental projects.

Despite the potential for cane-based feed, CARICOM's emphasis on corn/soya may be advisable. Because the livestock industry is accustomed to using these inputs, direct import substitution will imply minimal adjustment in current feeding practices. Unlike cane-feed, corn/soya concentrates are storable. Locational changes in existing livestock industries can be minimized through their production and greater flexibility in the future location of livestock feeding can be obtained. A final advantage is the potential for the development of a feed processing industry, which produces a valuable by-product--soya oil--in a region which is deficient in vegetable oils.

In summary, an evaluation of direct import substitution of corn and soya is needed. Such an evaluation should emphasize the costs of production, processing and transportation; implications for the use of land and labor resources; and the effect upon the foreign exchange position of CARICOM. The remainder of this study deals with the development and application of a framework for the analysis of these factors.

3. ANALYTICAL FRAMEWORK

Increasingly, programming models are being employed to analyze national and regional resource allocation problems, and the implications of policy instruments used in attaining policy objectives (Heady and Egbert; Pineiro and McCalla). In this section, the programming model used in this study is developed, and the data base summarized.

3.1 The Programming Model

A programming model is used to determine the optimum allocation and distribution of agricultural products within CARICOM for the year 1975. Combined production and transportation costs are minimized under three alternative import substitution scenarios for feed grains and related products: (a) free trade; (b) regional self-sufficiency in feed; and (c) regional self-sufficiency in vegetable oil.

The model generates an optimum allocation of resources (mainly land) among corn, soya, and sugar production. It also generates the optimal distribution of products between production and consumption locations within the Region.

Mathematically, the model is formulated as follows:

(1) Minimize $Z_0 = \sum_{i=1}^{I} \sum_{g=1}^{G} \alpha_{ig} Y_{ig} + \sum_{i=1}^{I} \sum_{j=1}^{J} \sum_{g=1}^{G} c_{ijg} X_{ijg}$,

subject to

(2) $$\sum_{g=1}^{G} Y_{ig} \leq S_i (i=1,\ldots,I);$$

(3) $$-a_{ig} Y_{ig} + \sum_{j=1}^{J} X_{ijg} \leq 0 \quad (i=1,\ldots,I; g=1,\ldots,G);$$

(4) $$\sum_{i=1}^{I} X_{ijg} \geq D_{jg} \quad (j=1,\ldots,J; g=1,\ldots,G);$$

$$X_{ijg} \geq 0; \; Y_{ig} \geq 0 \text{ (for all i, j, g)};$$

where

Y_{ig} = acres of commodity g produced at origin i;

a_{ig} = output per acre of commodity g at origin i;

X_{ijg} = units (tons or gals.) of commodity g transported from origin i to destination j;

α_{ig} = the cost/acre of producing commodity g at origin i;

c_{ijg} = the transport cost/unit of commodity g from origin i to destination j;

S_i = the supply of land at origin i; and

D_{jg} = the demand for commodity g at destination j.

Import substitution could have several impacts on the agricultural sector. In the long run, prices and quantities would be affected by changes in trade policy. The costs of production and distribution would nevertheless be minimized within the constraints imposed by such policy. The cost minimization objectives implicit in the programming model reflect only part of the adjustment that is likely to take place in the long run. For the purposes of the analysis, it was necessary to assume that minimum levels of final demand can be specified exogenously.[1/] This assumption is probably not unreasonable in the short run. To deal with longer run effects would require a nonlinear programming model in which prices and quantities are determined simultaneously. The information necessary to construct such a model was not available. However, the linear programming model does generate some information on equilibrium prices for fixed levels of demand. Equilibrium prices are embodied within the dual of the programming problem, which can be expressed as:

(5) $$\text{Minimize } Z^* = \sum_{i=1}^{I} S_i L_i - \sum_{j=1}^{J} \sum_{g=1}^{G} D_{jg} Q_{jg},$$

subject to

(6) $$L_i - a_{ig} P_{ig} \geq -\alpha_{ig} \quad (i=1,\ldots,I; g=1,\ldots,G);$$

(7) $$P_{ig} - Q_{jg} \geq - c_{ijg} \quad (i=1,\ldots,I; j=1,\ldots,J; g=1,\ldots,G);$$

(8) $$L_i \geq 0;\ P_{ig} \geq 0;\ Q_{jg} \geq 0 \quad (\text{for all } i, j, g)$$

where

L_i = the rent/acre of land;

1/ A strict application of project appraisal techniques to import substitution policy would require that the costs of production and distribution reflect the social opportunity costs of resources (Little and Mirlees). In developing countries, characterized by labor surplus economies, existing wage rates may not reflect the social opportunity cost of labor. Similarly, the exchange rate may not be an equilibrium rate, implying that domestic resources may be over- or under-valued relative to the value of resources internationally.

P_{ig} = the value of product g at origin i;

Q_{jg} = the value of product g at destination j; and other terms are as defined in equations (1) - (4).

The interpretation of the dual can be simplified by rewriting equation (6) as

$$a_{ig}P_{ig} - L_i \leq \alpha_{ig}.$$

That is, gross revenue/acre less the rent/acre is constrained to be less than or equal to the cost of production. Equation (7), rewritten as

$$Q_{jg} - P_{ig} \leq c_{ijg}$$

constrains the value of the product at its destination less the value at its origin to be less than or equal to the transport cost.

The dual, therefore, generates implicit values for land, and the products at their origins and destinations. The latter are of particular policy interest. As demonstrated by Waverman, minimum preventive tariffs (tariffs which reduce imports from outside the Region to zero) can be obtained by comparing the free trade programming solution with a solution in which imports of a particular commodity are prohibited. The difference between the imputed value at a destination derived from the restricted model and the imputed price under free trade is equal to the tariff that would reduce imports to zero. Such a tariff is one policy instrument that could be used to achieve import substitution.

3.2 Empirical Formulation

There are six sub-regions in the programming model. Five of them are the largest individual countries within CARICOM (the MDCC's plus Belize); the sixth represents CARICOM's international markets (the "rest of the world"). Each of the sub-regions represents both a supply origin and demand destination for one or more agricultural products. A brief discussion of agricultural activities and resource availabilities in each sub-region is presented below. Production and transport costs, resource availabilities, and product demands relate to 1975 and are summarized in tables 3.1-3.4.[1/] Background information on the activities and constraints outlined below is given by Charles.

Guyana

In the programming model, four production activities are included for Guyana. They are sugar cane, which occupies land for the entire year, and feed grains, which are double cropped and can be grown in the

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1/ Data in these tables are rounded for ease of presentation. However, all calculations are based on actual numbers reported by Charles.

Table 3.1 Programming Activities by Country, 1975

Country of Origin	Activity	Yield per Acre[a/]	Cost per Acre ($)[b/]
Guyana	Sugar	2.8 tons	691
	1 crop corn & 1 crop soya	1.1 tons corn 0.5 ton meal 29.6 gals. oil	443[c/]
	2 crops corn	2.2 tons	480[c/]
	2 crops soya	1.0 ton meal 53.2 gals. oil	403
Trinidad & Tobago	Sugar (Estate)	2.6 tons	793
	Sugar (Peasant)	2.5 tons	878
	1 crop corn & 1 crop soya	1.8 tons corn 0.6 ton meal 33.5 gals. oil	490
	2 crops corn	3.1 tons	450
Jamaica	Sugar (Mechanizable Estate)	3.2 tons	806
	Sugar (Other)	2.7 tons	799
	1 crop corn & 1 crop soya	1.6 tons corn 0.5 ton meal 29.4 gals. oil	631
	2 crops soya	1.1 tons meal 59.1 gals. oil	640
Belize	Sugar	2.4 tons	719
	1 crop corn & 1 crop soya	1.1 tons corn 0.5 ton meal 29.6 gals. oil	513[c/]
	2 crops corn	2.2 tons corn	550[c/]
Barbados	Sugar (High Rainfall)	3.4 tons	800
	Sugar (Moderate Rainfall)	2.1 tons	623
	Sugar (Low Rainfall)	1.1 tons	452

Note: See Charles for sources.

a/ Measured in long tons and imperial gallons.

b/ Soya costs include costs of processing into meal and oil.

c/ Land clearing costs included.

Table 3.2 Imported Commodities from Outside CARICOM, 1975

Country of Destination	Price per Unit[a/]		
	Corn	Soya Meal	Soya Oil
	----------$----------		
Guyana	269	382	3.90
Trinidad & Tobago	187	279	4.70
Jamaica	160	193	3.60
Barbados	211	270	5.70

Note: See Charles for sources.

a/ Prices are c.i.f.; corn and soya meal measured in long tons, soya oil in imperial gallons.

Table 3.3 Land Resource Restrictions, 1975

Country	Activity	Acres Available
Guyana	Sugar	142,400
	Corn/Soya	20,000
Trinidad & Tobago	Sugar (Peasant)	42,000
	Estate Sugar/Corn/Soya	60,000
Jamaica	Sugar (Other)	79,200
	Mechanizable Estate Sugar/Corn/Soya	46,600
Belize	Sugar	34,600
	Corn/Soya	7,500
Barbados	Sugar (High Rainfall)	20,200
	Sugar (Moderate Rainfall)	18,900
	Sugar (Low Rainfall)	6,300

Note: See Charles for sources.

following rotations: corn/soya, corn/corn, and soya/soya. The land constraint for sugar cane consists of the existing sugar acreage of approximately 142 thousand acres. This land is generally unsuitable for feed grains. However, approximately 20 thousand acres of presently undeveloped land could be made available for feed-grain production. Demand constraints represent domestic sugar requirements and imports of corn, soya meal, and vegetable oil in 1975.

Table 3.4 Demand Requirements (Actual Consumption or Exports), 1975

Country	Product	Demand[a/]
Guyana	Domestic Sugar	31,500 tons
	Corn	6,200 tons
	Meal	6,200 tons
	Oil	457,500 gals.
	Export Sugar	282,400 tons
Trinidad & Tobago	Domestic Sugar	42,500 tons
	Corn	76,700 tons
	Meal	19,000 tons
	Oil	1,087,400 gals.
	Export Sugar	69,000 tons
Jamaica	Domestic Sugar	103,200 tons
	Corn	115,400 tons
	Meal	31,400 tons
	Oil	2,539,600 gals.
	Export Sugar	118,300 tons
Belize	Domestic Sugar	6,100 tons
	Export Sugar	75,000 tons
Barbados	Domestic Sugar	15,400 tons
	Corn	11,600 tons
	Meal	1,900 tons
	Oil	311,400 gals.
	Export Sugar	78,700 tons

Note: See Charles for sources.

a/ Measured in long tons and imperial gallons.

Trinidad and Tobago

Production activities in Trinidad and Tobago consist of two sugar activities, one each for peasant and estate sugar cane, and two feed grain rotations--corn/soya and corn/corn. Separate land constraints are defined for peasant and estate sugar cane. Feed grains are allowed to compete with sugar cane only on estate sugar lands, which are better suited to feed grain production in terms of topography and size of holdings. The demand constraints for sugar include both domestic demand and the production required to meet the EC export quotas. Other demand constraints are determined on the basis of import demands as in the case of Guyana.

Jamaica

Sugar cane activities in Jamaica are divided into those which can and cannot be mechanized. Mechanization can only occur on some of the estate lands. Those which are not suited to mechanization are combined with unmechanized sugar production on peasant land holdings. Feed grains are divided into the two rotations corn/soya and soya/soya. These are allowed to compete with sugar only on mechanizable estate lands. Demand constraints are developed in a similar way to those for Trinidad and Tobago.

Belize

Belize can engage in three production activities: sugar, corn/soya, and corn/corn. Like Guyana, sugar and feed grains do not compete for the same land; sugar production is limited to existing sugar acreage, while 7,500 acres of undeveloped lands can be devoted to feed grains. This is the maximum acreage set aside for a regional corn/soya project in Belize. The only demand constraint for Belize is domestic sugar. Demand for feed grains is insignificant. All feed grain production is assumed to be exported to other countries within the Region.

Barbados

The three sugar activities defined for Barbados are distinguished on the basis of high, moderate, and low rainfall regimes. These have significant differential effects on yields and are associated with different costs of production. Land constraints are included for each regime. No feed grain activities are specified for the country because it is ecologically unsuited to the production of these crops. Demand constraints are derived in a fashion similar to those for Trinidad and Tobago.

Imports

Under free trade, imports of corn, soya meal, and soya oil from outside CARICOM are allowed. To generate import substitution solutions, imports are restricted to allow for self-sufficiency in either feed grains or soya.

4. EMPIRICAL RESULTS

In 1975 there was no significant production of feed[1/] in any of the five CARICOM countries analyzed. Sugar was produced for export, and all

1/ Throughout the discussion of the empirical results, "feed" denotes corn and soya meal.

Table 3.5 Transport Costs for Corn and Soya Meal, 1975

Origins	Destinations			
	Barbados	Guyana	Jamaica	Trinidad & Tobago
	- - - - - - - - $ per long ton[a/] - - - - - - - -			
Trinidad & Tobago	43	43	60	0
Guyana	50	0	64	43
Belize	95	104	50	100
Jamaica	55	64	0	60

Source: West Indies Shipping Corporation, Trinidad (unpublished).

a/ Handling charges included.

Table 3.6 Transport Costs for Soya Oil, 1975

Origins	Destinations			
	Barbados	Guyana	Jamaica	Trinidad & Tobago
	- - - - - - $ per imperial gallon[a/] - - - - - - -			
Trinidad & Tobago	0.28	0.28	0.43	0
Guyana	0.33	0	0.48	0.28
Belize	0.68	0.78	0.38	0.73
Jamaica	0.41	0.48	0	0.43

Source: West Indies Shipping Corporation, Trinidad (unpublished).

a/ Handling charges included.

feed demands were met by imports. This actual or "base" situation is the point of departure for analyzing the feasibility of import substitution of feed by CARICOM. The solutions to the programming model under the scenarios discussed in the previous section provide comparative empirical estimates of feed production, costs, and trade under three levels of import substitution: (a) free trade; (b) regional self-sufficiency in feed; and (c) regional self-sufficiency in vegetable oil.

A description of these scenarios and their associated costs, in addition to those of the base situation, are provided in table 4.1. These include the variable costs of obtaining the services of land, labor, machinery, and equipment for the production and processing of the final products. Also included are the costs of imported feed and vegetable oil, and costs of transporting all products from supply

origins to demand destinations. The costs are discussed below in connection with agricultural production and distribution.

Table 4.1 Variable Costs of Agricultural Production and Distribution Under Alternate Scenarios

Scenario	Variable Cost[a/] $ million
0 Base Situation (1975)[b/]	475.3
1 Free Trade	317.5 (363.7)[c/]
2 Self-Sufficiency in Feed	328.0 (330.0)[c/]
3 Self-Sufficiency in Vegetable Oil	328.3 (345.3)[c/]

a/ The associated variable costs refer to the variable cost of producing feed grains and/or sugar plus the cost of importing all or a part of the feed grain requirements.

b/ The base situation is not a product of the programming model. It is the existing situation in which sugar is produced for export and all feed grains are imported.

c/ These figures include the cost of producing sugar for export to world markets on sugar land which is left idle in the programming model.

4.1 Agricultural Production and Distribution

Free Trade Scenario

In the free trade case, the variable costs of the agricultural production and imports, needed to meet the specified 1975 demands for feed and sugar is $317.5 million. This represents a 33 percent reduction from the costs estimated for the base situation ($475.3 million). The reduction in costs implies a substantial change in existing production and trade patterns. These are summarized in table 4.2.

Under free trade, production of feed occurs only in Guyana and Trinidad and Tobago. Approximately 6,200 tons of soya meal, and 347 thousand gallons of soya oil are produced in Guyana, while in Trinidad and Tobago, roughly 94,500 tons of corn, 21 thousand tons of meal, and 1.2 million gallons of soya oil are produced. Guyana satisfies all of its domestic meal requirements, a quarter of its vegetable oil requirements, and two-thirds of the vegetable oil demand in Barbados. Guyana

Table 4.2 Production and Distribution of Agricultural Products Under Free Trade Scenario

Origins	Product[a/]	Destinations: Guyana	Trinidad & Tobago	Jamaica	Belize	Barbados	Extra-regional (Rest of World)	Total Supply[b/]
Guyana	Corn							0
	Soya Meal	6,199						6,199
	Soya Oil	110,243				236,656		346,899
	Sugar	31,546					364,384	395,930
Trinidad & Tobago	Corn	6,188	76,720			11,592		94,500
	Soya Meal		18,963			1,865		20,828
	Soya Oil		1,087,428			74,756		1,162,184
	Sugar		42,527				69,000	111,527
Jamaica	Corn							0
	Soya Meal							0
	Soya Oil							0
	Sugar			103,167			118,300	221,467
Belize	Corn							0
	Soya Meal							0
	Soya Oil							0
	Sugar				6,096		77,982	84,078
Barbados	Sugar					15,406	99,761	115,167
Extra-regional (Rest of World)	Corn			115,357				115,357
	Soya Meal			31,357				31,357
	Soya Oil	347,246		2,539,642				2,886,888
Total Demand[b/]	Corn	6,188	76,720	115,357	0	11,592		209,857
	Soya Meal	6,199	18,963	31,357	0	1,865		58,384
	Soya Oil	457,489	1,087,428	2,539,642	0	311,412		4,395,971
	Sugar	31,546	42,527	103,167	6,096	15,406	729,427	928,169

a/ Corn, soya meal, and sugar are measured in long tons, soya oil in imperial gallons.

b/ Detail does not add due to rounding.

imports the remaining three-quarters of its soya oil from extra-regional sources. Trinidad and Tobago meets all of its domestic demand for corn, meal, and vegetable oil as well as all of Guyana's demand for corn, Barbados' total demand for corn and meal, and a quarter of its demand for vegetable oil. Therefore, under free trade conditions, not only does production of feed take place in two countries, but increased trade develops among three countries (Guyana, Trinidad and Tobago, and Barbados). In Trinidad and Tobago, self-sufficiency is achieved in both oil and feed at 1975 demand levels. Jamaica is the only country which continues to import all of its domestic requirements of feed and vegetable oil from extra-regional sources. No production of feed takes place in either Jamaica or Belize.

Feed Self-Sufficiency Scenario

Feed self-sufficiency requires only $10 million more than the agriculturally-related expenditures under the free trade case. Under this scenario, production of corn occurs in an additional CARICOM country--Guyana (table 4.3). Production in Guyana is approximately: 6,200 tons of corn; 16,700 tons of soya meal; and 933 thousand gallons of soya oil. The country is, therefore, able to meet all of its requirements for feed and vegetable oil, as well as to export meal and oil to Barbados and Jamaica, and oil to Trinidad and Tobago. Trinidad and Tobago produces approximately 138 thousand tons of corn, 19 thousand tons of meal and 1.1 million gallons of soya oil. In Jamaica, 66 thousand tons of corn, 22 thousand tons of meal and 1.3 million gallons of soya oil are produced.

Under free trade, Guyana produces only soya, Trinidad and Tobago produces both corn and soya, and Jamaica, which produces neither crop, imports all of its requirements from outside the Region. However, under feed self-sufficiency, the allocation of production changes significantly. Guyana, Trinidad and Tobago, and Jamaica each produce both corn and soya, but in such a manner that trade within the Region is increased.

Under free trade, intra-regional trade is limited to shipments of corn from Trinidad and Tobago to Guyana and Barbados, meal from Trinidad and Tobago to Barbados, and oil from Guyana to Barbados. The quantities transported are considerably less than under self-sufficiency in feed; 21 thousand tons are shipped under free trade compared to 74 thousand tons under self-sufficiency. However, even when self-sufficiency in feed is assumed, some extra-regional oil is still imported by Jamaica, indicating that the Region may not be simultaneously self-sufficient in feed and vegetable oil.

Vegetable Oil Self-Sufficiency Scenario

In the previous scenario, feed constituted the major demand constraint. Under regional self-sufficiency in feed, vegetable oil production still fell short of demand by over 1.1 million gallons. The minimum cost strategy for meeting this shortfall was to import soya oil from outside the Region. In the current scenario, vegetable oil demand is the major constraint of the model. Regional self-sufficiency in

Table 4.3 Production and Distribution of Agricultural Products Under Regional Self-Sufficiency in Feed

Origins	Product[a/]	Destinations: Guyana	Trinidad & Tobago	Jamaica	Belize	Barbados	Extra-regional (Rest of World)	Total Supply[b/]
Guyana	Corn	6,188						6,188
	Soya Meal	6,199		8,997		1,483		16,679
	Soya Oil	457,489	7,991	155,859		311,412		932,752
	Sugar	31,546					364,384	395,930
Trinidad & Tobago	Corn		76,720	49,543		11,592		137,854
	Soya Meal		18,963			382		19,345
	Soya Oil		1,079,437					1,079,436
	Sugar		42,527				69,000	111,527
Jamaica	Corn			65,815				65,815
	Soya Meal			22,360				22,360
	Soya Oil			1,246,682				1,246,682
	Sugar			103,167			118,300	221,467
Belize	Corn							0
	Soya Meal							0
	Soya Oil							0
	Sugar				6,096		77,982	84,078
Barbados	Sugar					15,406	99,761	115,167
Extra-regional (Rest of World)	Corn							0
	Soya Meal							0
	Soya Oil			1,137,100				1,137,100
Total Demand[b/]	Corn	6,188	76,720	115,357		11,592		209,857
	Soya Meal	6,199	18,963	31,357		1,865		58,384
	Soya Oil	457,489	1,087,428	2,539,642		311,412		4,395,971
	Sugar	31,546	42,527	103,167	6,096	15,406	729,427	928,169

a/ Corn, soya meal, and sugar are measured in long tons, soya oil in imperial gallons.

b/ Detail does not add due to rounding.

soya oil is obtained for only $0.5 million more than the cost of self-sufficiency in feed. However, feed demands are met at minimum cost by importing just over 106 thousand tons of corn into Jamaica.[1/]

The distribution of production under this scenario is also interesting (table 4.4). Once more, Guyana, and Trinidad and Tobago both produce at full capacity, Guyana produces 19 thousand tons of meal and 1.1 million gallons of oil, while Trinidad and Tobago produces 104 thousand tons of corn, 35 thousand tons of meal and 1.9 million gallons of oil. Guyana and Jamaica specialize exclusively in soya production, while Trinidad and Tobago alone produces both corn and soya. As a result, Guyana imports corn from Trinidad and Tobago, and exports oil to Barbados and Jamaica, while Trinidad and Tobago, which becomes self-sufficient in both feed and vegetable oil, exports corn to Guyana; corn, meal and oil to Jamaica; and corn and meal to Barbados. In addition, more than 20 thousand tons of surplus meal become available for export from Guyana and Trinidad and Tobago to extra-regional destinations. This results from the joint-product nature of soya production facing independent demands for meal and oil.

4.2 Resource Use

The focus of the previous sub-section was the extent to which production requirements could be met under various import substitution objectives. From a policy perspective, it is also important to know the implications of these objectives for agricultural resource use. Land and labor provide the primary focus because of the scarcity of the former, and the lack of employment for the latter.

Land

The total acreage incorporated in the model is 477,720 acres. This represents all the sugar cane land in the four MDCC's and Belize plus an additional 27,500 acres of uncleared land in Guyana and Belize. Land use for each scenario is shown in table 4.5. The acreage occupied by corn and soya ranges from 51,500 acres under free trade (scenario 1) to 120 thousand acres under feed self-sufficiency (scenario 2). This demonstrates the feasibility of satisfying the bulk of the regional demand for feed and vegetable oils, at 1975 levels, with no more than 25 percent of the Region's sugar land.

In table 4.5, unutilized land in Guyana and Belize, which is currently uncleared and undeveloped, is referred to as "idle" land. The variations in feed grain acreage under the alternative scenarios are made possible by movements into and out of "idle" land, in response to different levels of import substitution. The base situation is a close approximation of existing conditions in which there is "idle" (undeveloped) land only in Guyana and Belize. In the free trade situation, import substitution of feed grains involves diversification of sugar land. Under the cost minimization objective function and free trade conditions,

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1/ Regional self-sufficiency in both vegetable oil and feed was not possible given limited land resources and 1975 levels of demand in feed, oil and sugar.

Table 4.4 Production and Distribution of Agricultural Products with Regional Self-Sufficiency in Soya Oil

Origins	Product[a/]	Destinations: Guyana	Trinidad & Tobago	Jamaica	Belize	Barbados	Extra-regional (Rest of World)	Total Supply[b/]
Guyana[c/]	Corn							0
	Soya Meal	19,000						19.000
	Soya Oil	457,489		294,299		311,412		1,063,200
	Sugar	31,546					364,384	395,930
Trinidad & Tobago[d/]	Corn	6,188	76,720	9,044		11,592		103,544
	Soya Meal		26,289	6,554		1,865		34,708
	Soya Oil		1,087,428	849,251				1,936,679
	Sugar		42,527				69,000	111,527
Jamaica	Corn							0
	Soya Meal			24,804				24,804
	Soya Oil			1,396,093				1,396,093
	Sugar			103,167			118,300	221,467
Belize	Corn							0
	Soya Meal							0
	Soya Oil							0
	Sugar				6,096		77,982	84,078
Barbados	Sugar					15,406	99,761	115,167
Extra-regional (Rest of World)	Corn			106,313				106,313
	Soya Meal							0
	Soya Oil							0
Total Demand[b/]	Corn	6,188	76,720	115,357		11,592		209,857
	Soya Meal	19,000	26,289	31,357		1,865		78,511
	Soya Oil	457,489	1,087,428	2,539,642		311,412		4,395,971
	Sugar	31,546	42,527	103,167	6,096	15,406	729,427	928,169

a/ Corn, soya meal, and sugar are measured in long tons, soya oil in imperial gallons.

b/ Detail does not add due to rounding.

c/ After CARICOM's demands are met, 12,801 tons of surplus meal are available in Guyana.

d/ After CARICOM's demands are met, 7,326 tons of surplus meal are available in Trinidad and Tobago.

the demands for sugar, feed, and vegetable oil are met most cheaply by entering into some feed production, reducing feed imports and sugar production, and leaving some sugar land and some undeveloped lands unutilized.

Table 4.5 Agricultural Land Use (In Acres)

Country	Activity[a/]	Base	Scenario[b/] 1	2	3
Guyana	Corn/Soya	0	0	5,525	0
	Corn/Corn	0	0	0	0
	Soya/Soya	0	6,526	14,475	20,000
	Sugar	142,421	142,421	142,421	142,421
	"Idle"	20,000	13,474	0	0
Trinidad and Tobago	Corn/Soya	0	34,713	32,241	57,846
	Corn/Corn	0	10,340	25,605	0
	Sugar E	60,000	2,154	2,154	2,154
	Sugar P	42,000	42,000	42,000	42,000
	"Idle"	0	12,793	0	0
Jamaica	Corn/Soya	0	0	42,189	0
	Soya/Soya	0	0	0	23,623
	Sugar ME	46,588	1,876	1,876	1,876
	Sugar O	79,201	79,201	79,201	79,201
	"Idle"	0	44,712	2,523	21,090
Belize	Corn/Soya	0	0	0	0
	Corn/Corn	0	0	0	0
	Sugar	34,600	34,600	34,600	34,600
	"Idle"	7,500	7,500	7,500	7,500
Barbados	Sugar H	20,240	20,240	20,240	20,240
	Sugar M	18,880	18,880	18,880	18,880
	Sugar L	6,290	6,290	6,290	6,290
CARICOM	Corn/Soya	0	34,713	79,955	57,846
	Corn/Corn	0	10,340	25,605	0
	Soya/Soya	0	6,526	14,475	43,623
	Sugar	450,220	347,662	347,662	347,662
	"Idle"	27,500	78,480	10,023	28,590

a/ For sugar, E = Estate; P = Peasant; H = High Rainfall; M = Moderate Rainfall; L = Low Rainfall; O = Other; and ME = Mechanizable Estate. "Idle" lands are undeveloped lands in Guyana and Belize; or unused sugar cane lands in Jamaica and Trinidad and Tobago.

b/ See table 4.1 for a description of the scenarios.

The level of import substitution increases under scenario 2, with the requirement of self-sufficiency in feed. This forces feed production upwards. The increased production is achieved by drawing on some, but not all, of the land which was "idle" in scenario 1. Since a major proportion of the "idle" land in 1975 was actually occupied by sugar, it can be considered "idle" only in terms of the optimum results for a specific scenario. It is likely that such land would continue to produce sugar for export rather than remaining uncultivated.

In scenario 3, the import substitution emphasis is placed on self-sufficiency in vegetable oil. This is achieved by adjustments to the land-use pattern made possible, in part, by the idling of sugar land in Jamaica, and the utilization of undeveloped land in Guyana.

According to the programming results in table 4.5, corn and soya production is confined to Guyana, Trinidad and Tobago, and Jamaica except for scenario 1 in which no production occurs in Jamaica. The results indicate that Guyana possesses the best competitive potential for expansion of production. Were it not for the fact that some sugar cane land in Jamaica would either be left idle or allowed to produce sugar uneconomically at existing world market prices, it would be rational from a regional perspective if grain production were expanded in Guyana to meet the needs of Jamaica.

Under free trade, the effect of extra-regional competition plays an important role in excluding grain production from Jamaica. This is related to Jamaica's location. The major extra-regional source of supply is the U.S.; Jamaica is closer to the U.S. than the other MDCC's and, therefore, transport costs are lower. In addition, Jamaica has the largest demand for these agricultural products in CARICOM and may be able to obtain better prices through bulk purchasing.

These two factors combine to reduce the cost of feed imported into Jamaica from extra-regional sources. They also reduce both the competitive position of Jamaica's feed grain production in relation to extra-regional sources and the ability of other regional producers to compete with extra-regional suppliers to the Jamaican market. Additionally, locational factors (specifically distance from the U.S.), and size of import demand enhance the competitive position of Guyana, and Trinidad and Tobago, particularly in relation to extra-regional suppliers. These factors explain Jamaica's relatively poor competitive status, and the apparently superior positions of Guyana, and Trinidad and Tobago as reflected in the land-use results. Additional factors include relatively high costs of production in Jamaica, and the absence of a double corn crop activity because of rainfall limitations.

Labor

Discussion focuses on labor requirements on land that has the potential to be used for corn and soya production. Data on labor requirements for some production activities in certain countries were unobtainable. In an attempt to overcome this, those for Trinidad and Tobago are used

for all countries. The labor-use figures employed relate to the most capital-intensive feed grain production technology available. The ratio of the labor requirement for estate and peasant sugar cane production in Jamaica was used to compute the requirement for estate cane production in Trinidad and Tobago. The data in table 4.6 constitute the basis of the analysis. Total man days per year employed in the production of corn and soya with capital intensive technology, and in any sugar production that corn/soya would displace is given in table 4.7.

Table 4.6 Labor Requirements

Country	Production Activity	Labor Requirement
		man days per acre
All corn/soya producing countries[a/]	Corn/corn	6
	Corn/soya	11
	Soya/soya	16
Jamaica[b/]	Peasant sugar cane	15
	Estate sugar cane	12
Trinidad & Tobago	Peasant sugar cane[c/]	35
	Estate sugar cane[d/]	28

a/ These labor requirements, computed for Trinidad and Tobago, are used for all countries (Radley).

b/ These estimates were provided by the Jamaica Sugar Industry Research Institute.

c/ This estimate was based on 1976 cost data of the Trinidad Islands-wide Cane Farmers Association.

d/ The ratio of the labor requirement between estate and peasant production is assumed to be the same as in Jamaica.

Guyana, Trinidad and Tobago, and Jamaica are the three countries in which significant variation in labor demand occurs. The demand for labor varies with each scenario and with the activity mix. In all the scenarios, feed production in Guyana generates increased employment relative to the 1975 situation, because new land is brought into production. The smallest increase occurs in scenario 1, while the highest occurs in scenario 3. Guyana is the only country where the net demand for labor shows an increase in response to all import substitution strategies.

The results for Trinidad and Tobago, and Jamaica present a contrast in terms of overall labor requirements. Feed production would demand half as much labor as estate sugar in Trinidad and Tobago. In Jamaica,

Table 4.7 Labor Use for Feed Grains

Country	Scenario: Free Trade 1	Feed Self-Sufficiency 2	Oil Self-Sufficiency 3
	man days per year		
Guyana	104,409	292,375	320,000
Trinidad & Tobago	443,881 (1,261,475)a/	499,282 (1,619,684)	636,304 (1,619,684)
Jamaica	-	464,078 (506,267)	377,961 (283,471)

a/ Labor requirements for the sugar cane equivalent are in parentheses.

corn/soya production requires slightly less labor than estate sugar cane, but soya/soya requires slightly more. These results indicate that while feed production could have adverse employment effects in Trinidad and Tobago, the effects in Jamaica are likely to depend on the product mix.

The fact that employment in agricultural production may decline significantly as the result of import substitution may present particular problems for Trinidad and Tobago, and Jamaica. For this reason, three additional programming specifications were considered in which the use of labor-intensive feed grain technology was assumed in these two countries. As table 4.8 indicates, costs of production for the three feed grain rotations increase by at least 38 percent. These changes in the costs of production are reflected in the objective function coefficients of the programming model.

The major programming results, i.e., production and trade patterns under these assumptions, are included in the Appendix. Although there are several changes in production, the most important is reflected in the employment summary in table 4.9. Belize, which produced no feed grains under capital-intensive technology in Jamaica and Trinidad and Tobago, enters the self-sufficiency scenarios as an exporter to other CARICOM countries. Employment effects in Jamaica and Trinidad and Tobago are significant under self-sufficiency. In both cases, Jamaica has a substantial net increase in employment when compared to the sugar production displaced. However, Trinidad and Tobago still experiences a net reduction of employment of 15 percent under feed self-sufficiency.

4.3 Trade Policy and Foreign Exchange

The results of the programming model suggest that under free trade, CARICOM will not be self-sufficient in either feed or vegetable oil. In order to achieve self-sufficiency, trade policy instruments would probably have to be employed. The instruments which are considered are import quotas and tariffs.

Table 4.8 Labor Requirements for Labor-Intensive Feed Grain Technology

Country	Production Activity	Labor Requirement
		man days per acre
Guyana & Belize (Capital Intensive)	Corn/corn	6
	Corn/soya	11
	Soya/soya	16
Jamaica & Trinidad & Tobago (Labor Intensive)	Corn/corn	12 (38%)[a/]
	Corn/soya	34 (42%)
	Soya/soya	56 (53%)
Jamaica	Peasant sugar cane	15
	Estate sugar cane	12
Trinidad & Tobago	Peasant sugar cane	35
	Estate sugar cane	28

a/ Percentages in parentheses indicate increase in total cost of production per acre for labor versus capital-intensive technology.

Labor 4.9 Labor Use with Labor-Intensive Technology for Feed Grains

Country	Scenario		
	Free Trade 1	Feed Self-Sufficiency 2	Oil Self-Sufficiency 3
	- - - - - - - - - - - -man days per year- - - - - - - - - - -		
Guyana	292,375	292,375	320,000
Trinidad & Tobago	0	1,380,084 (1,619,684)[a/]	1,794,967 (1,478,208)
Jamaica	0	1,220,297 (430,700)	1,273,154 (272,819)
Belize	0	82,500	82,500

a/ Labor requirements for the sugar cane equivalent are in parentheses.

Import Quotas

Regional self-sufficiency in both feed and vegetable oil is not achieved simultaneously within the constraints specified in the model. In each strategy, imports of either feed or vegetable oil from outside the Region are required. In scenario 2, the imports of vegetable oil constitute the import quota necessary to ensure that self-sufficiency in

feed is achieved. Conversely under scenario 3, imports of corn and soya meal constitute the quota necessary to ensure self-sufficiency in vegetable oil. These quotas are given in table 4.10.

Table 4.10 Import Quotas Under Self-Sufficiency

Country/Commodity	Imports from Outside CARICOM under Free Trade[a]	Import Quotas under Self-Sufficiency Scenarios	
		Feed	Oil
	- - - - - - - thousand units - - - - - - -		
Guyana			
Soya Oil (gallons)	347.25	0	0
Jamaica			
Corn (tons)	115.36	0	106.31
Soya Meal (tons)	31.36	0	0
Soya Oil (gallons)	2,539.64	1,137.10	0

a/ Under free trade, imports of the various commodities into other CARICOM countries from outside the region are zero. Therefore, quotas are not needed to restrict imports by these countries under self-sufficiency.

To meet self-sufficiency objectives, only two countries, Guyana and Jamaica, would need to employ import quotas. Under both scenarios, imports of soya oil into Guyana and soya meal into Jamaica would have to be prohibited. Under self-sufficiency in feed, imports of soya oil into Jamaica would be restricted to 45 percent of their free trade level. Under self-sufficiency in vegetable oil, imports of corn into Jamaica would be restricted to 92 percent of their free trade level.

Superficially, quotas appear to be desirable because of their administrative simplicity, and because they would only have to be employed by two countries. However, the use of quotas is frowned upon by the international community. They are technically illegal under the General Agreement on Tariffs and Trade (GATT), and could invite retaliation. For these reasons, other alternatives should not be ignored. One clear alternative is the use of import tariffs.

Tariffs

In order to estimate required tariffs, it is necessary to examine the market prices that would obtain for agricultural products under the various scenarios. Market (shadow) prices are derived from the dual programming problem specified in section 3. These are presented in table

4.11. The programming model guarantees that where imports from outside the Region occur under any scenario the shadow prices are equivalent to 1975 import prices. Where shadow prices are below import prices, the product's value at its destination is lower than the cost of importing it, and no trade with countries outside the Region will occur at that destination.

Table 4.11 Import Prices and Imputed (Shadow) Market Prices

		Scenarios[a]			
		Import Prices '75 (Base Case)	1	2	3
		$[b]			
Guyana	Corn	268.65	186.76	195.01	143.11
	Soya Meal	381.55	205.72	252.50	0[c]
	Soya Oil	3.90	3.90	3.07	9.29
Trinidad and Tobago	Corn	187.29	143.76	169.80	100.11
	Soya Meal	278.99	167.87	259.50	0[c]
	Soya Oil	4.66	3.95	3.35	9.34
Jamaica	Corn	160.11	160.11	229.80	160.11
	Soya Meal	193.28	193.28	316.50	60.00
	Soya Oil	3.55	3.55	3.55	9.77
Barbados	Corn	210.74	186.76	212.80	143.11
	Soya Meal	269.76	210.87	302.50	43.00
	Soya Oil	5.69	4.23	3.40	9.62

a/ Scenario 1 = free trade; 2 = self-sufficiency in feed; 3 = self-sufficiency in soya oil.

b/ Corn and soya meal prices are per long ton; soya oil price is per imperial gallon. The differences in 1975 import prices reflect distances from sources of supply and differential freight rates.

c/ These zero prices result from there being excess meal produced in the countries.

Under the self-sufficiency scenarios, there are instances in which shadow prices are above import prices. Imports from outside the Region do not occur under these circumstances because they are prohibited in the model's specification. As discussed earlier, the difference between the shadow and import price represents the specific tariff needed to prevent all imports of a commodity.

In the feed self-sufficiency strategy (scenario 2), specific tariffs are required only on corn and meal in importing countries (table 4.12).

None is required on soya oil because of the joint product nature of oil and meal, which ensures substantial quantities of oil production when meal demand is the limiting factor. Similarly, in the strategy for self-sufficiency in vegetable oil, (scenario 3), a tariff is required only on oil. In this case, both the joint product nature of meal and oil, and the rotation systems established for corn and soya, operate to obviate the need for tariffs on corn and meal. In addition, surplus meal (in excess of regional demands) becomes available in Guyana, and Trinidad and Tobago.

Table 4.12 Minimum Preventive Tariffs Assuming 1975 Import Prices

Country	Product	Self-Sufficiency Scenario	
		Feed	Oil
		- - - $ per unit[a/] - - -	
Guyana	Soya Oil	-	5.39 (138)
Trinidad and Tobago	Soya Oil	-	4.68 (100)
Jamaica	Corn	69.69 (44)	-
	Soya Meal	123.22 (64)	-
	Soya Oil	-	6.22 (175)
Barbados	Corn	2.06 (1)	-
	Soya Meal	32.74 (12)	-
	Soya Oil	-	3.93 (69)

Note: These tariffs are calculated by subtracting the import price from imputed market prices in table 4.11 when the difference is positive. Theoretically, Waverman suggests that the minimum preventive tariff would be the free trade imputed prices subtracted from the imputed prices under self-sufficiency. In some cases, where tariffs are required, 1975 import prices are greater than imputed free trade prices. This difference can be interpreted as an existing "implicit tariff". The preventive tariff is therefore less than the difference between the imputed prices.

a/ Corn and soya meal are in long tons; soya oil is in imperial gallons. Numbers in parentheses represent the ad valorem equivalent (percentage of the import price) of the specific tariff.

There are two principal observations that can be made about the tariffs. The first is their size relative to the corresponding import price in most cases. As the ad valorem equivalents indicate, 5 of the 8 tariffs are in excess of 50 percent, and they range as high as 175 percent. Introducing tariffs of this magnitude would probably be politically impossible.

A second problem is the implications of tariffs for the developing Caribbean Common Market. In practice, a common market requires the harmonization of tariff schedules, and in particular, the adoption by member countries of a common external tariff, which usually takes the form of an ad valorem instead of a specific tariff. The Region is currently seeking to establish ad valorem common external tariffs by the early 1980's (Caribbean Community Secretariat). While it may be relatively less difficult to arrive at political agreement on such a scheme, it is unlikely to be appropriate for achieving import substitution in feed or vegetable oil.

The transport costs (and probably also differences in purchasing economies) from the major extra-regional source of feed (the U.S.), constitute a significant portion of landed costs, and result in great disparities in c.i.f. prices between the various countries. For example, the 1975 c.i.f. price for corn in Guyana is 68 percent higher than that in Jamaica. A common external tariff on corn of 10 percent would raise the price of corn in Jamaica to $176, while the price in Guyana will be increased to $296 per ton. The percentage difference in price would remain unchanged, but the nominal difference would have increased by almost $11. One effect of this would be increased costs of livestock producers in Guyana and reduce their competitive advantage relative to those in Jamaica. Another important effect is the potential which could be created for arbitrage within the Region. The Jamaica-Guyana price difference of 10 percent created by a common external tariff is almost twice the cost of transporting the product between the two countries. This increases the temptation for Jamaica to re-export feed ingredients to Guyana at substantial profit. Similar repercussions could occur among the other sub-regions. The aggravating effects of a common external tariff on the large price differences which already exist in the Region, suggest that such a tariff is unlikely to be an efficient instrument for import substitution.

As an alternative, the type of minimum import price/variable levy policy employed for many agricultural products in the European Community may be appropriate.[1/] Different minimum import prices could be

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1/ A variable levy is assessed as the difference between world price and a fixed "minimum import price". It therefore fluctuates with changes in world prices and ensures that no imports enter a country at a price less than the minimum import price. Variable levy revenues can fluctuate considerably but this is irrelevant if, as in the current case, the minimum import price is specifically intended to control imports, rather than to raise revenue. It would not be necessary to continually renegotiate the level of protection, as would be required for specific or ad valorem tariffs.

established for the members of CARICOM to ensure differential degrees of protection (ad valorem tariff equivalents). The scheme would also ensure that imports are kept at desired levels, even when import prices decline.

Foreign Exchange

In less-developed countries, foreign exchange is needed to obtain imported goods, particularly capital goods, to accelerate economic development. Bruno argued that import substitution enterprises should be evaluated on the basis of total real resource cost per unit of net foreign exchange saved. Ideally, such a calculation would reflect the netting out of any import component of costs. Information on import content was unavailable. However, the principal imported input is machinery, and both corn and soya use similar machinery. Therefore, while the ratios of resource cost per unit of foreign exchange saved in table 4.13 may be biased downward, the relative magnitudes among countries are likely to remain unaffected. The fact that the ratios in Guyana and Trinidad and Tobago are considerably below those in Jamaica, explains the production patterns in the free trade solution. Corn and soya production in the former countries is relatively efficient compared to the import alternative, in the latter country it is relatively inefficient. It is not until self-sufficiency in either feed or oil is imposed that production occurs in Jamaica.

Table 4.13 Resource Cost/Unit of Foreign Exchange Saved at 1975 c.i.f. Prices

Country	Activity	Resource Cost/ Unit of Foreign Exchange Saved	Ranking
Guyana	Soya/Soya	0.70	1
	Corn/Soya	0.73	2
Trinidad and Tobago	Corn/Soya	0.75	3
	Corn/Corn	0.77	4
Jamaica	Corn/Soya	1.38	5
	Soya/Soya	1.55	6

Note: Derived from cost, yield and price information in tables 3.1 and 3.2.

Although these ratios are of interest, the overall foreign exchange position under import substitution is also affected by what happens to sugar exports as sugar land is diverted to corn and soya production. In table 4.14, estimates are given of the effect of import substitution on the foreign exchange position of CARICOM and its constituent countries, affected by the policy. The figures include the foreign exchange "lost"

Table 4.14 Impact of Import Substitution on the Foreign Exchange Position, 1975

	Scenario		
	Free Trade 1	Feed Self-Sufficiency 2	Oil Self-Sufficiency 3
	$ millions		
Guyana			
Increase in Sugar Export Earnings	0	0	0
Feed and Vegetable Oil			
Reduction in Non-CARICOM Import Expenditures	+ 4.46	+ 5.81	+ 5.81
Increase in Exports to CARICOM	+ 1.00	+ 4.94	+ 5.87
Reduction in Imports from CARICOM	- 1.16	0	- 0.89
Net Improvement in Foreign Exchange Position	+ 4.30	+ 10.75	+ 10.79
Trinidad and Tobago			
Increase in Sugar Export Earnings	- 74.61 (- 58.11)	- 74.61	- 74.61
Food and Vegetable Oil			
Reduction in Non-CARICOM Import Expenditures	+ 24.73	+ 24.73	+ 24.73
Increase in Exports to CARICOM	+ 4.03	+ 13.97	+ 12.76
Reduction in Imports from CARICOM	0	0	0
Net Improvement in Foreign Exchange Position	- 45.85 (- 29.35)	- 35.91	- 37.12
Jamaica			
Increase in Sugar Export Earnings	- 76.89 (0.0)	- 76.89 (- 72.55)	- 76.89 (- 40.62)
Feed and Vegetable Oil			
Reduction in Non-CARICOM Import Expenditures	0	+ 29.51	+ 16.53
Increase in Exports to CARICOM	0	0	0
Reduction in Imports from CARICOM	0	- 14.79	- 13.01
Net Improvement in Foreign Exchange Position	- 76.89 (0.0)	- 62.17 (- 57.83)	- 73.37 (- 37.10)
Barbados			
Increase in Sugar Export Earnings	0	0	0
Feed and Vegetable Oil			
Reduction in Non-CARICOM Import Expenditures	+ 4.72	+ 4.72	+ 4.72
Increase in Exports to CARICOM	0	0	0
Reduction in Imports from CARICOM	- 3.87	- 4.09	- 4.73
Net Improvement in Foreign Exchange Position	+ 0.85	+ 0.63	- 0.01
CARICOM			
Increase in Sugar Export Earnings	-151.50 (- 58.11)	-151.50 (-147.16)	-151.50 (-115.23)
Feed and Vegetable Oil			
Reduction in Non-CARICOM Import Expenditures	+ 33.91	+ 64.77	+ 51.79
Increase in Exports to CARICOM	+ 5.03	+ 18.91	+ 18.63
Reduction in Imports from CARICOM	- 5.03	- 18.91	- 18.63
Net Improvement in Foreign Exchange Position	-117.59 (- 24.20)	- 86.73 (- 82.39)	- 99.71 (- 63.44)

Note: Figures in parentheses include exports of sugar at world prices from sugar land which is "idled" in the programming solutions. These figures include the foreign exchange "lost" as the result of displacement of sugar production valued at 1975 world market prices; the savings resulting from the reduction in feed and vegetable oil imports from outside CARICOM, also valued at 1975 world market (import) prices; and for each country, earnings or expenditures resulting from trade in feed and vegetable oil with other CARICOM members. In the latter case, expenditures on imports are calculated using the relevant destination price in table 4.11; earnings from exports are calculated using the price at their origin. Figures in parentheses reflect adjustments for continued production of sugar for export on land "idled" in programming solutions.

as the result of displaced sugar production valued at 1975 world market prices; the savings resulting from the reduction in feed and vegetable oil imports from outside CARICOM, also valued at 1975 world market (import) prices; and for each country, earnings or expenditures resulting from trade in feed and vegetable oil with other CARICOM members. In the latter case, expenditures on imports are calculated using the relevant destination price in table 4.11; earnings from exports are calculated using the price at their origin. Expenditures on transport costs, both in intra- and extra-regional trade, are treated as a foreign exchange expenditure (loss) even though some may accrue to the countries concerned through national (flag) carriers.

As table 4.14 demonstrates, only two countries, Guyana and Barbados, realize a net foreign exchange saving from import substitution. In Guyana's case, this is because its production of feed and vegetable oil does not displace existing sugar production. It gains by saving on imports from extra-regional sources, and also (with the exception of the free trade case) through a net positive balance of trade with other CARICOM countries. In two of the three scenarios, Barbados has an overall net gain, since its expenditure on CARICOM-produced feed and oil is lower than the cost of obtaining these from outside the Region.

In Trinidad and Tobago, and Jamaica, the loss of foreign exchange from displaced sugar production totally dominates the results. Since Trinidad and Tobago is an exporter of feed/oil under all scenarios, its losses are less than those of Jamaica, which is primarily an importer. However, the scenarios all reflect the inclusion of the value of reduced sugar exports from land which is left "idle" in the programming solutions. If it is assumed that such land would, because of institutional reasons, continue to produce sugar for export at world market prices, then the loss of foreign exchange by Jamaica, and Trinidad and Tobago would be substantially reduced. As table 4.14 indicates, the smallest loss to CARICOM as a whole is under free trade ($24.2 million). Of the two self-sufficiency scenarios, the smaller loss occurs under self-sufficiency in vegetable oil ($63.44 m.).[1/] Nevertheless, under all scenarios at 1975 prices, there is a net loss in foreign exchange from the production of feed/vegetable oil in CARICOM. This result is largely due to abnormally high prices that existed for sugar during the year chosen for analysis. The "world" price of sugar (International Sugar Council price f.o.b. Caribbean) in 1977-78, for example, was only about 40 percent of the price in 1975 (IBRD).

1/ A further factor could reduce this "loss". Under oil self-sufficiency, surplus meal is produced in both Trinidad and Tobago and Guyana. If this were to be exported at an f.o.b. price of 80 percent of the 1975 c.i.f. European price of meal (IBRD), or $126 per long ton, then Guyana would realize additional export earnings of $1.61 m. and Trinidad and Tobago an additional $0.92 m. This would imply a further reduction of the net loss in foreign exchange to $60.91 m.

Clearly one's view of the potential effects of import substitution for feed/vegetable oil, depends to a great extent upon one's future assessment of the relative prices of these products with respect to sugar. Since 1975, there has been a substantial change in the ratio between world prices of corn and soybeans, and sugar. Using ratios derived from World Bank statistics (IBRD), the corn/sugar ratio (1975=100) was 210 for the years 1977-78. The corresponding soybean/sugar ratio was 249.[1/] Therefore, the ratio between feed and sugar has improved by 110 to 150 percent in recent years. On this basis, the use of sugar prices which would be more representative of future prospects than those employed, would probably portray import substitutions' effects on foreign exchange earnings in a more favorable light.

The potential loss of foreign exchange earnings from sugar, although probably not as large as indicated in table 4.13, has had an impact on experimental development of feed and vegetable oil production in the Region.

The current strategy towards the development of the industry is to concentrate production in Guyana and Belize, which possess large amounts of uncleared land on which grains can be cultivated. The significance of this strategy lies in the fact that by concentrating production in these two sub-regions, the Region does not sacrifice foreign exchange earnings from sugar. CARICOM appears to be so sensitive to foreign exchange "losses" that it prefers to incur the substantial development costs associated with the location of feed production in currently undeveloped areas of Guyana and Belize, rather than reduce export earnings by diverting sugar land into feed production. Foreign exchange considerations take precedence over cost consideration to the extent that gross foreign exchange earnings, rather than minimum cost, appear to be implicitly determining the location of feed production within the Caribbean Community. This explains the apparent inconsistency between the locational results of the model, and existing developments within CARICOM. It explains why the Region has focused attention on expanding feed production in Belize, while the results of the model consistently exclude Belize as a producing country. The driving force of the model is cost minimization, while the driving force of regional governments appears to be the maximization of foreign exchange availability. Cost minimization strategies are likely to face opposition from policymakers unless they simultaneously satisfy foreign exchange objectives.

5. SUMMARY AND CONCLUSIONS

In recent years, two important themes in LDC trade policy have emerged--import substitution, and the formation of customs unions. To

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1/ These are computed by taking representative world prices per metric ton and computing their ratio. The 1975 ratio is then set equal to 100 and the indexed value of the 1977-78 value calculated. The prices employed are corn--U.S. #2 yellow Gulf Ports; soybeans--U.S. #2 bulk c.i.f. Rotterdam; and sugar--International Sugar Council f.o.b. Caribbean.

cope with balance of trade problems and to avoid dependence on imported food, the emphasis on import substitution has been shifting from manufactured to agricultural products. Advocates of LDC customs unions point to the traditional benefits from specialization and the possibility of "more equitable" trading relationships between nations at similar levels of economic development. To date, little empirical work has been done on identifying the economic viability of agricultural import substitution in LDC's, and the degree to which customs unions could contribute to its achievement. The Caribbean Community, because of its emphasis on import substitution for livestock feed, provides an ideal setting for such an empirical evaluation.

In response to growing consumer demand, livestock production in CARICOM increased rapidly in the 1970's. This change has not been accompanied by a parallel development of a livestock feed industry. As a result, expanding feed requirements have primarily been met through increased imports of corn and soya. These imports have placed an added burden on already scarce supplies of foreign exchange, and have stimulated Community interest in the possibility of import substitution.

The purpose of this study is to examine the economic feasibility of various degrees of import substitution for corn and soya. These include the feasibility of developing a corn/soya industry under free trade conditions, and CARICOM self-sufficiency in livestock feed or in vegetable oil. The costs of import substitution and its implications for land and labor use, sugar production and exports, and the foreign exchange balance under 1975 conditions are assessed. The required quotas or tariff levels to achieve self-sufficiency objectives are estimated.

The analysis was conducted via a linear programming framework, within which the production and transportation cost of meeting CARICOM's agricultural demands were minimized. The data used in the model were obtained primarily from research and government institutions and trade publications from the Region. Because CARICOM's corn/soya industry is in its early stages of development, costs and production information from pilot projects was employed.

Despite the simplicity of the model employed and the use of a particular year (1975) as the basis for analysis, the results obtained provide useful pointers for the development of a corn/soya industry in the Region. First, under 1975 conditions, the cost of producing corn and soya in the Region were sufficiently low for it to compete with imports under free trade. That is, if a corn/soya industry had existed in 1975 under the cost conditions assumed, it would have reduced Community corn imports by 45 percent, soya meal imports by 46 percent, and soya oil imports by 34 percent. Jamaica is the only country which continues to import all its corn/soya requirements from outside CARICOM. Second, land and labor resources within the Community are not adequate to achieve self-sufficiency in both feed and soya oil. However, self-sufficiency in one or the other is possible. Because soya meal and oil are joint products, self-sufficiency in feed does reduce soya oil imports by an additional 40 percent from existing 1975 levels.

Self-sufficiency in soya oil generates a surplus of meal, but 51 percent of the Region's corn requirements must still be imported.

Although self-sufficiency can be achieved at a relatively modest additional cost compared to free trade with the 1975 price relationships assumed, there are significant implications for resource use and foreign exchange. For example, feed grain production unambiguously generates increased employment in Guyana since undeveloped land is brought into production. When land which was used for sugar production in 1975 is diverted into capital intensive corn/soya production in Trinidad and Tobago, employment is reduced. In Jamaica, employment on diverted land is decreased under self-sufficiency in feed, but increased under self-sufficiency in soya oil. This result stems from the fact that sugar production in Jamaica is less labor-intensive than in Trinidad and Tobago. Even if labor-intensive corn/soya production methods were adopted, there would still be a reduction of agricultural employment in Trinidad and Tobago under feed self-sufficiency.

Because of differential production costs, regional self-sufficiency does not necessarily imply self-sufficiency for all member countries. In general, Guyana and Trinidad and Tobago become net exporters to Barbados and Jamaica. Therefore, trade within the Community is enhanced.

Import substitution affects the foreign exchange position of the members of CARICOM in three ways. In Guyana and Barbados, export earnings from sugar remain constant because 1975 production is equivalent to contractual commitments. Guyana saves foreign exchange in meeting its soya needs, and has a net foreign exchange surplus in its corn/soya trade with other CARICOM countries. Barbados generally saves foreign exchange by meeting its corn/soya requirements from CARICOM exporters rather than from higher cost extra-regional sources.

In contrast, land currently in sugar production in Trinidad and Tobago is diverted into corn/soya production under import substitution. Therefore, even though production of corn and soya is sufficient to meet its own requirements and to generate sizable foreign exchange earnings from exports to other CARICOM countries, the reduction in sugar export at 1975 prices leads to a deterioration in its net foreign exchange position.

Under regional self-sufficiency, Jamaica saves some foreign exchange by meeting some of its own corn/soya needs from its own production. These savings are partially offset by expenditures on imports from other CARICOM countries. However, because corn/soya production in Jamaica displaces sugar for export to the world market, its overall foreign exchange position deteriorates significantly at 1975 prices.

The programming results suggest that the implications of import substitution for CARICOM's individual member countries are mixed. The trade restrictions needed to achieve self-sufficiency add further complications. Superficially, it appears that quotas, required only in Guyana and Jamaica, provide the simplest means to control imports. The use of quotas is not viewed favorably in the international community.

Prohibitive tariffs provide a theoretical alternative, but in practice, the rates required would generally be over 50 percent and would differ between member countries. Since CARICOM has been attempting to harmonize its tariffs and adopt a common external tariff, harmonization on the maximum rate needed to ensure self-sufficiency could result in excessive protection in some of the member countries. Trade patterns within the Community could be disrupted.

In conclusion, import substitution of corn and soya appears to be economically feasible for CARICOM, but the costs and benefits are unevenly distributed within the Community. This fact, combined with institutional problems associated with the implementation of trade restrictions, would make it difficult to achieve regional self-sufficiency. However, the competitiveness of a number of countries under free trade suggest that the promotion of a corn/soya industry through pilot projects, educational programs, and the removal of existing institutional impediments could be worthwhile.

APPENDIX

Programming Results for Labor-Intensive Technology

Tables A.1 through A.3 give the production and distribution of agricultural products within CARICOM derived from three additional solutions of the programming model. They correspond to scenarios 1 through 3 respectively in table 4.1. They differ from the results reported in tables 4.2-4.4 because the costs of production of corn and soya in Jamaica and Trinidad and Tobago are increased to reflect the use of labor-intensive rather than capital-intensive technology. The difference in per acre labor requirements reflected by the change can be seen by comparing the data in tables 4.6 and 4.8. Table A.4 gives the land use for the three scenarios under these labor-intensive assumptions. Total labor use corresponding to the three programming solutions is given in table 4.9.

Table A.1 Production and Distribution of Agricultural Products Under Free Trade with Labor-Intensive Technology in Jamaica, and Trinidad and Tobago

Origins	Products[a/]	Destinations: Guyana	Trinidad and Tobago	Jamaica	Belize	Barbados	Extra-Regional (Rest of World)	Total Supply[b/]
Guyana	Corn	6,188						6,188
	Soy Meal	6,199	10,480					16,679
	Soy Oil		621,340			311,412		932,752
	Sugar	31,546					364,384	395,930
Trinidad & Tobago	Corn							0
	Soy Meal							0
	Soy Oil							0
	Sugar		42,527				69,000	111,527
Jamaica	Corn							0
	Soy Meal							0
	Soy Oil							0
	Sugar			103,167			118,300	221,467
Belize	Corn							0
	Soy Meal							0
	Soy Oil							0
	Sugar				6,096		77,982	84,078
Barbados	Sugar					15,406	99,760	115,166
Extra-regional (Rest of World)	Corn		76,720	115,357		11,592		203,669
	Soy Meal		8,483	31,357		1,865		41,705
	Soy Oil	457,489	466,088	2,539,642				3,463,219
Total Demand[b/]	Corn	6,188	76,720	115,357		11,592		209,857
	Soy Meal	6,199	18,963	31,357		1,865		58,384
	Soy Oil	457,489	1,087,428	2,539,642		311,412		4,395,971
	Sugar	31,546	42,527	103,167	6,096	15,406	729,426	928,168

a/ Corn, soya meal, and sugar are measured in long tons, soya oil in imperial gallons.

b/ Detail does not add due to rounding.

Table A.2 Production and Distribution of Agricultural Products Under Regional Self-Sufficiency in Feed with Labor-Intensive Technology in Jamaica, and Trinidad and Tobago

Origins	Products[a/]	Destinations: Guyana	Trinidad and Tobago	Jamaica	Belize	Barbados	Extra-Regional (Rest of World)	Total Supply[b/]
Guyana	Corn	6,188						6,188
	Soy Meal	6,199	255	8,360		1,865		16,679
	Soy Oil	457,489	43,562	120,289		311,412		932,752
	Sugar	31,546					364,384	395,930
Trinidad & Tobago	Corn		76,720	50,966		11,592		139,278
	Soy Meal		18,707					18,707
	Soy Oil		1,043,866					1,043,866
	Sugar		42,527				69,000	111,527
Jamaica	Corn			55,991				55,991
	Soy Meal			19,023				19,023
	Soy Oil			1,060,599				1,060,599
	Sugar			103,167			118,300	221,467
Belize	Corn			8,400				8,400
	Soy Meal			3,975				3,975
	Soy Oil			221,625				221,625
	Sugar				6,096		77,982	84,078
Barbados	Sugar					15,406	99,760	115,166
Extra-regional (Rest of World)	Corn							
	Soy Meal							
	Soy Oil			1,137,129				
Total Demand[b/]	Corn	6,188	76,720	115,357		11,592		209,857
	Soy Meal	6,199	18,963	31,357		1,865		58,384
	Soy Oil	457,489	1,087,428	2,539,642		311,412		4,395,971
	Sugar	31,546	42,527	103,167	6,096	15,406	729,426	928,168

a/ Corn, soya meal, and sugar are measured in long tons, soya oil in imperial gallons.

b/ Detail does not add due to rounding.

Table A.3 Production and Distribution of Agricultural Products Under Regional Self-Sufficiency in Soya Oil with Labor-Intensive Technology in Jamaica, and Trinidad and Tobago

Origins	Products[a/]	Destinations: Guyana	Trinidad and Tobago	Jamaica	Belize	Barbados	Extra-Regional (Rest of World)	Total Supply[b/]
Guyana[c/]	Corn							0
	Soy Meal	19,000						19,000
	Soy Oil	457,489		294,299		311,412		1,063,200
	Sugar	31,546					364,384	395,930
Trinidad & Tobago[d/]	Corn	6,188	76,720			11,592		94,500
	Soy Meal		26,300	3,511		1,865		31,676
	Soy Oil		1,087,428	680,086				1,767,514
	Sugar		42,527				69,000	111,527
Jamaica	Corn							0
	Soy Meal			23,872				23,872
	Soy Oil			1,343,632				1,343,632
	Sugar			103,167			118,300	221,467
Belize	Corn			8,400				8,400
	Soy Meal			3,975				3,975
	Soy Oil			221,625				221,625
	Sugar				6,096		77,982	84,078
Barbados	Sugar					15,406	99,760	115,166
Extra-regional (Rest of World)	Corn			106,957				106,957
	Soy Meal							
	Soy Oil							
Total Demand[b/]	Corn	6,188	76,720	115,357		11,592		209,857
	Soy Meal	19,000	26,300	31,357		1,865		78,522
	Soy Oil	457,489	1,087,428	2,539,642		311,412		4,395,971
	Sugar	31,546	42,527	103,167	6,096	15,406	729,426	928,168

a/ Corn, soya meal, and sugar are measured in long tons, soya oil in imperial gallons.

b/ Detail does not add due to rounding.

c/ After CARICOM's demands are met, 12,800 tons of surplus meal are available in Guyana.

d/ After CARICOM's demands are met, 7,337 tons of surplus meal are available in Trinidad and Tobago.

Table A.4 Agricultural Use Under Labor-Intensive Technology in Jamaica and Trinidad and Tobago (in Acres)

Country	Activity[a/]	Base	Scenario[b/] 1	2	3
Guyana	Corn/Soya	0	5,525	5,525	0
	Corn/Corn	0	0	0	0
	Soya/Soya	0	14,475	14,475	20,000
	Sugar	142,421	142,421	142,421	142,421
	"Idle"	20,000	0	0	0
Trinidad	Corn/Soya	0	0	31,179	52,793
	Corn/Corn	0	0	26,667	0
	Sugar E	60,000	2,154	2,154	2,154
	Sugar P	42,000	42,000	42,000	42,000
	"Idle"	0	57,846	0	5,053
Jamaica	Corn/Soya	0	0	35,892	0
	Soya/Soya	0	0	0	22,735
	Sugar ME	46,588	1,876	1,876	1,876
	Sugar O	79,201	79,201	79,201	79,201
	"Idle"	0	44,712	8,820	21,977
Belize	Corn/Soya	0	0	7,500	7,500
	Corn/Corn	0	0	0	0
	Sugar	34,600	34,600	34,600	34,600
	"Idle"	7,500	7,500	0	0
Barbados	Sugar (H)	20,240	20,240	20,240	20,240
	Sugar (M)	18,880	18,880	18,880	18,880
	Sugar (L)	6,290	6,290	6,290	6,290

a/ For sugar, E = Estate; P = Peasant; H = High Rainfall, M = Moderate Rainfall; L = Low Rainfall; O = Other; ME = Mechanizable Estate. "Idle" lands are undeveloped lands in Guyana and Belize; or unused sugar cane lands in Jamaica and Trinidad and Tobago.

b/ See table 4.1 for a description of the scenarios.

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