CHARLES S. FRANK

the sugar industry in east africa

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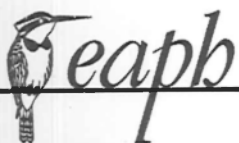
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THE SUGAR INDUSTRY IN EAST AFRICA

An Analysis of Some Problems and Policy Questions Relating to the Expansion of the Sugar Industry in a Developing Economy

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PREFACE

This study, like Topsy, just grew from a very small beginning. In the fall of 1963, the East African Common Services Organization became very much interested in considering some outstanding policy questions with regard to sugar manufacture in East Africa. In particular, since there were numerous proposals for new sugar factories and since East Africa was on the verge of self sufficiency in sugar production, there was the vital question of how exports would be conducted, who would do the exporting, and who would supply the internal East African markets. Dr. Peter Newman, then the economic advisor of the East African Common Services Organization, suggested that in formulating policy it would be of help to know whether the three East African countries could make substantial savings in transport costs by pooling their sugar supplies, distributing sugar on a rational basis internally, and exporting from those factories which were situated close to East African ports. The alternative, which was a very real possibility at the time, was that each of the East African countries separately would sign trade agreements or negotiate quotas for exports, and at the same time supply their own internal markets as much as possible, importing only if necessary. My study of this problem, using a linear programming model, became the basis for Chapter IV of this volume and stimulated an interest in two related policy questions. The first was whether sugar industry in East Africa should be developed and how fast, and the second was what rate of growth in internal consumption could be expected. An analysis of these two problems evolved into Chapters V and III, respectively. Chapter II, which is a brief description of the sugar industry in East Africa, was inspired by the paucity of material on the sugar industry in East Africa. Chapters I and VI were added to complete and summarize the study of the development of the sugar industry in East Africa.

Most of the data and information used in this study come from primary sources as there is little published material dealing with the sugar industry of East Africa. Much of the data on yields, growing seasons, the labour force and various types of costs were taken from replies to a questionnaire sent to the sugar manufacturers. The Ministries of Agriculture and of Commerce and Industry in all three countries and the East African Common Services Organization provided much basic information from their files and through conversations and correspondence with their employees. Other observations are based on visits to various East African sugar

CHAPTER I

INTRODUCTION AND SUMMARY

The most important policy issue concerning the sugar industry is the rate at which production should be expanded. This depends on the real opportunity costs of sugar production and the benefits derived from the output of sugar as well as the production of by-products. The benefits are dependent both on the growth of the internal market and on the availability of markets for export.

Related to the question of the desirability of an expansion of the industry are a whole set of policy issues concerning the proper governmental measures necessary to achieve that rate of expansion. Foremost among these is future price policy. The price of sugar to the manufacturer is fixed by law in all of East Africa[1]. Consumer prices, which are fixed either by law or by force of governmental persuasion, are very much affected by the level of the excise tax on sugar. Geographic price differences and the relation between the internal price of sugar and the world market price are important policy issues. Minimum wage legislation, governmental attitudes towards potential investors, and labour union policy also affect the private evaluation of costs and benefits which may be different from estimates of social costs and benefits.

A final set of policy problems involves the degree of co-operation among the three East African countries. If the three East African countries agree on a policy of expansion, then they may also agree on a policy of expansion where costs are the lowest, taking into consideration the special needs of specific areas for development. Even if such a degree of co-operation on the location of the industry is not possible, co-operation can still take place in the area of marketing and distribution. Co-operation in this area will also require an accommodation of policies concerning the ex-factory and consumer prices, excise taxes, and import and export licensing in the three countries.

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1. Throughout this study East Africa will refer to the countries of Uganda, Kenya, and the mainland part of Tanzania which we will call Tanganyika.

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A. A Description of the Industry

Chapter II of this study is purely descriptive and covers those facts which will have a direct bearing on the analysis in later chapters. The description of past trends in production, consumption, and trade in Chapter II reveals that Uganda has had a consistent surplus of production over consumption from 1955 to 1964 ranging from about 10,000 tons to nearly 50,000 tons while Kenya and Tanganyika have had persistent shortfalls over the period 1953 to 1953, although Tanganyika had a slight surplus in 1964. During the same period East Africa as a whole has had a shortfall of about 50,000 tons except for 1963 and 1964 when the shortfalls were reduced to about 12,000 tons and 26,000 tons, respectively. Production and consumption in 1964 in East Africa were both over 200,000 tons. Per capita consumption in East Africa has been growing from about 13 pounds in 1953 to about 20 pounds in recent years. The Uganda surplus production has been exported mainly to Kenya, while both Kenya and Tanganyika have imported sugar from abroad through most of the period 1953-64.

Per capita sugar consumption is very high in the urban areas of East Africa, and there are very large differences among provinces and districts. Most of the sugar is consumed by a small and relatively wealthy proportion of the population. Industrial consumption accounts for only three to five per cent of total consumption, most sugar being consumed directly by households.

The price of sugar to the producer in East Africa is approximately the same in all three countries and is based on the Commonwealth Sugar Agreement Price. Distribution is arranged by the government in Kenya and by private or co-operative state trading agencies in Uganda and Tanganyika. The retail price to the consumer is about 50 per cent higher than the ex-factory price. Over half of the difference is attributable to the excise tax on sugar.

Of the nine East African sugar mills, there are two in Uganda, two in Kenya and five in Tanganyika. Three producers in Tanganyika, however, are relatively small. Cane is grown under extremely varied conditions concerning temperature, rainfall, altitude, soils, and topography. Much of the cane is grown using irrigation. Yields of cane per acre and the length of time between the planting of cane and its maturation vary considerably depending on the conditions under which the cane is grown.

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B. An Analysis and Projection of Sugar Demand

Chapter III is an analysis of the various factors affecting sugar consumption and an attempt to project the demand for sugar to 1970. This analysis was prompted by several policy considerations. Present plans in all three East African countries call for a major expansion in sugar production in East Africa by 1970. There is some concern over finding export markets for the surplus sugar production both by prospective producers and the three East African governments. The extent of the surplus depends, of course, on the rate at which internal consumption can be expected to grow. Some suggestions have been made urging a reduction in the internal price of sugar in order to stimulate demand. The elasticity of sugar consumption with respect to price is certainly an important consideration in determining whether such a policy would be effective.

Several projection equations were estimated with time series data for 1954 to 1963 using least squares estimation techniques. The 1970 projected consumption for Uganda is about 116,000 tons, for Kenya about 176,000 tons and for Tanganyika about 106,000 tons of sugar. The total projection for East Africa is 398,000 tons. The expected statistical error in these projections, given a set of assumptions concerning future incomes and sugar prices, is about plus or minus 5 per cent.

The rate of growth of consumption should be about 8.8 per cent between 1963 and 1970 compared with a 6.6 per cent rate of growth between 1953 and 1963 if the target rates of growth in income specified in development plans are achieved.

The projections are fairly sensitive to the assumptions made concerning the expected future rate of growth of Gross Domestic Product. A slow rate of growth of GDP would be a major inhibiting factor as concerns consumption. Income changes, however, seem to affect sugar consumption only after a lag or a period greater than one year after the change in incomes take place. The immediate effect of a rise in income is relatively weak. Price changes also seem to have very little effect on consumption, at least in the short run. The low estimated price elasticity of demand for sugar suggests that a reduction of the retail price of sugar would not have the effect of greatly expanding the internal market at least for some time.

The low estimated price elasticity of the demand for sugar is

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compared with results obtained by other investigators. Our conclusion of a low price elasticity is similar to price elasticities revealed by budget study data in several other developing countries but contradicts results obtained using cross-country data for a number of low income countries.

Little time series analysis of sugar consumption has been attempted in the developing countries. The difficulties of using time series data in an underdeveloped country are illustrated by the analysis in Chapter III.

C. Sugar Distribution and Transport Costs

Although agreement among the three countries locating the sugar industry where costs are lowest in East Africa may not be feasible, some agreement may be reached on the joint distribution of sugar in East Africa and the joint control of exports and imports. The major benefit of reaching such an agreement is a much more efficient system of distribution. For example, if Uganda manufacturers are not permitted to distribute sugar in Kenya, they will be forced to export their surplus of production over Uganda consumption some 800 miles overland to the port of Mombasa. This inefficient distribution could result in substantially increased transport costs.

On the other hand, certain benefits may accrue to each of the countries or may accrue to one or more but not all of the countries by failing to reach an agreement on the efficient distribution and the joint control of exports and imports of sugar. Without such an agreement each of the East African countries would have more freedom in setting the ex-factory price of sugar, in levying excise taxes on sugar, and in determining the consumer price of sugar. Differences in the internal sugar prices of the three East African countries could not be maintained as long as there is free movement across the borders. Individual countries may lose although East Africa as a whole may gain with an efficient system of distribution. For example, if the world price is lower than the East African internal price, a deficit country may be required to pay for high-priced imports from one of the other two East African countries under an efficient distribution system rather than obtain chean

one of the other countries and export sugar instead of satisfying its own consumption needs. In particular, Tanzania might receive imports from Uganda into Lake and West Lake Provinces which are far from the coast and export from its factories near the coast. If the world prices were lower than the internal East African price, Tanzania would be required to expand its exports for which it receives a low price and take high priced imports at the same time from another East African country. A price equalization scheme in which the same price was paid for all imports whether from an East African country or from outside and in which the same price was received for exports either to other East African countries or to the outside would go part way in making it more advantageous for *each* country to join in an agreement as well as East Africa as a whole. A price equalization scheme, however, would not necessarily eliminate completely the advantage to be gained by individual countries from abstaining from an agreement concerning distribution. For example, if two of the East African countries were completely self-sufficient while the third had a substantial exportable surplus, and if the world price were lower than the internal price, a price equalization scheme would mean that the two self-sufficient countries would effectively share in the lower price received by the surplus country. If, on the other hand, the two self-sufficient countries supplied only their own needs and did not agree on an East African distribution system nor on a price equalization scheme, they would receive a higher average price for all of their sugar.

Since East Africa as a whole stands to gain in the form of reduced transport costs if an efficient system of distribution on an East African basis can be arranged, there must exist some set of transfer payments between the countries, perhaps in the form of a modified price equalization scheme, in which no country would be disadvantaged and at least one or more of the countries would gain from an agreement concerning distribution and joint control of exports and imports. Other considerations such as maize marketing and control might be brought into any bargaining discussion. In the past Uganda has agreed to import maize from Kenya at the internal Kenya price even though the world price of maize was lower.

answer these questions, we set up a mathematical model of the transport and distribution of sugar in East Africa for the year 1970. This linear programming model is able to tell us both the form of the rational distribution system (the consumption areas supplied by each of the East African factories) and the savings in transport costs to be derived from a rational distribution. The results of the calculations show that with a rational distribution system Uganda would supply some of the area of Tanzania around Lake Victoria and parts of western Kenya. Tanganyika producers would supply parts of southern Kenya and Nairobi. Any exports outside of East Africa would be from Kenya and Tanzania. The savings resulting from such a distribution would amount to approximately £250,000 per annum as compared to a distribution system in which Tanzania did not import from Uganda and Kenya did not import from Tanzania and Uganda.

D. The Future Expansion of the Sugar Industry

Chapter V is an analysis of the relationship between the real (social or opportunity) cost of an expansion of the sugar industry and the real (social) benefits which would accrue from such an expansion. It is difficult to assess the cost of sugar production in East Africa because of the lack of published information on the industry and because of the natural reluctance of individual producers to reveal cost data. Some international comparisons can be made, however, between various indicators of costs such as land productivity (yields per acre) and labour productivity. These comparisons, if favourable for East Africa, do not necessarily mean that real or opportunity costs of production are lower in East Africa than elsewhere, but a *prima facie* case can be made for relatively low real costs of production.

Sugar cane yields per acre per annum are not only measures of land productivity but they may also be interpreted as indices of the returns to capital and labour. Much of the capital as well as recurrent expenses of sugar production are relatively fixed with respect to the amount of land which is cultivated. The higher the yield per acre, the smaller is the average of these fixed costs per unit of sugar produced. Yields from the unirrigated cane fields of Uganda near Lake Victoria of about 30 tons per acre per annum are quite high. The only major sugar cane growing countries which have substantially higher average per annum

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yields except for British Guiana (about 36 tons per acre per annum during 1955-59) are those in which the cane is irrigated. The average yields from the irrigated cane fields of northern Tanganyika and Uganda range from slightly over 40 tons to slightly over 50 tons per acre per annum. This compares very favourably with the yields of Hawaii and Peru (about 43 and 47 tons of cane per acre per annum during 1955-59, respectively) which had the highest average yields of any of the major cane producing countries during the period 1955-59. Kenya sugar yields, while not as good as those in Uganda and Tanganyika, compare favourably as well.

East Africa also compares favourably with other sugar producing countries in that the East African countries are among the few in which harvesting can take place all year round. Year round harvesting means that the capital invested in the factory and its machinery is more efficiently utilized.

East Africa compares unfavourably with other sugar producing countries in respect to labour productivity. Nearly half of the total work force is engaged in cutting cane, and productivity is about one ton per day on the average in East Africa while in Australia the average is about 7 tons per day. Caribbean cane cutters average about 2 to 3 tons per day. Although labour productivity is quite low, one must keep in mind that the opportunity cost of labour is also quite low in East Africa. If we take average per capita incomes as a rough measure of the relative opportunity cost of labour in the three countries, then the labour cost per ton of cane cut in Australia is nearly three times that in East Africa, and in Cuba it is nearly twice that in East Africa.

The capital employed in any industry has a relatively high opportunity cost in capital-scarce countries such as those of East Africa. If interest rates are assumed to be 10 per cent, the annual capital charges should comprise somewhat less than one-half of the value added in a new sugar enterprise. The sugar industry is labour intensive; about one-half of value added is labour cost. Since sugar is a relatively simple commodity to produce, the requirements of highly skilled technical manpower are almost nil.

Since much of the capital cost of the sugar industry is construction and land improvement, only about one-half of the capital cost of a sugar enterprise represents costs of imported capital goods. Recurrent import costs probably are no more than 15 per cent of the total value of output. The sugar industry is thus a moderate user

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of scarce foreign exchange compared to other East African industries.

Much of the benefits of an expansion of the sugar industry will accrue in the form of a reduction in the foreign exchange cost of supplying, partly by imports, an internal sugar market expanding at the rate of about 7 per cent per annum. If production expands faster than this, the United Kingdom should be able to accommodate East Africa by expanding its Commonwealth Sugar Agreement (CSA) quota from 10,000 to 50,000 tons by 1970 which would probably be more than enough to cover East Africa's exportable surplus. The average CSA price has been substantially above the world price for most of the last decade or so. Beyond the CSA, East Africa might look to the substantial imports into some of the neighbouring countries such as the Sudan and Aden.

An expansion of sugar into the export market offers a very good chance to diversify exports and stabilize export earnings, especially if an increased negotiated price quota under the CSA is obtained. An export surplus of 100,000 tons, which is achievable in the early 1970's if a vigorous expansion policy is pursued, could result in exports of nearly £4,000,000.

Other possible benefits accruing to increased sugar production in East Africa may be those derived from the production of sugar by-products. At present, molasses is being distilled for medicinal spirits and for alcohols used in gin distilleries. Some molasses is being exported as cattle feed. Other possible by-products derived from molasses include acetone, butanol, citric acid, lactic acid, dried yeast and other chemical products. Sugar cane wax, re-covered from filter muds, may be used in shoe wax, carbon paper, floor wax and other wax products. The fibrous cane waste, called bagasse, is at present used mostly for fuel but could be used as a raw material for packaging materials and building products such as hardboard and insulation.

Increased sugar production may help in absorbing the rapidly increasing numbers of people seeking employment in East Africa. Sugar production involves relatively large amounts of labour, about one man for every eight tons of sugar produced. If total East African production approached 500,000 tons by 1970, the total employment would be about 60,000 people. The amount of capital employed per worker in the sugar industry is approximately £2,200 at present day costs. This is probably substantially lower than most other industries.

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Finally, increased sugar production could lead to an expanded outgrower scheme. The average price paid for cane grown by peasant outgrowers ranges from Shs. 40/- to Shs. 47/- per ton. Peasant cash yields per acre should range between £20 and £30 at least. This compares very favourably with rough estimates of average cash yields per acre of most other East African crops, e.g., cotton about £7 and coffee about £23.

One of the disadvantages of the sugar industry is the lack of "backward linkage"; nearly all of the output is value added, i.e., represents labour and capital costs, while very small amounts of intermediate products are used relative to the value of the output.

Most of the evidence points to the conclusion that a vigorous expansion of the sugar industry is desirable and should be pursued. This conclusion needs to be verified by a more careful analysis of the cost structure of the industry with a proper evaluation of the opportunity costs of labour, capital, and foreign exchange.[1] It would be surprising, however, if such a thorough investigation would lead to any other conclusion.

E. Government Policy and the Future Expansion of the Industry

Government policy can affect the private or financial returns to investment in the sugar industry in several different ways. The government controls the price to the producer for sugar consumed internally and this is the most potent weapon which the government has for controlling the returns to the producer. The government could encourage the socially desirable rate of expansion of the sugar industry by setting the fixed price at the level which would encourage that amount of expansion. Several difficulties arise in doing so, however. First, the government has very little knowledge of the cost structure of the industry and setting the optimum price is impossible without this knowledge at least. Secondly, the government would have to have a knowledge of the way price interacts with other factors to determine the supply of investment into the sugar industry. The future level of the ex-factory price of sugar will probably have to be negotiated on an *ad hoc* basis with prospective investors. One can say, however, that a *reduced* ex-factory price is unlikely to

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1. An investigation into the cost structure of the sugar industry was authorized by the three East African governments. The investigation commenced in 1965 and was being conducted by an accounting expert, Mr. C. M. J. Bennett.

attract much investment into the industry. An alternative to a
fixed ex-factory price is to leave the price of sugar to fluctuate
according to the (world) market, perhaps levying an import duty
to protect local manufacturers. This has the disadvantage of
increased risk due to highly fluctuating prices, which are probably
not representative of any true scarcity situation as most of the world's
sugar is sold under negotiated price agreements. Another important
area of government policy is that concerning exports and imports.
If the internal price is to be different from the world price, exports
and imports will have to be controlled. In order to avoid the
pressures on government to obtain import licences or rights to sell
internally when the world price is low or export licences when the
world price is high, either the government will have to perform all
importation and exportation itself or some form of price equaliza-
tion scheme will have to be put into effect by the manufacturers and
exporting and importing agents themselves. If the government
does all importation and exportation itself directly, some form of
price equalization will have to be administered by government if
it wishes to avoid losses on importation when the world price is
high or on exportation when the world price is low.

The sugar industry in recent years has been characterized by a
great deal of labour strife, especially in Kenya and Uganda. The
management must be encouraged to improve its labour relations and
union leaders to gain better control over their members unless con-
tinued labour unrest is to act as a deterrent to propectives investors.

Land acquisition is sometimes very difficult for those wishing to
expand sugar production in East Africa because of the imperfect
market for land in East Africa. Some assurances must be given
by government that land which is suitable for sugar production
can be made available to prospective investors.

In the past, geographic price differentials stipulated by government
and unrelated to the combined influence of transport costs and local
surpluses or scarcities have resulted in faulty distribution and have
prevented the East African level of consumption from reaching its
potential. Some new policy ought to be formulated with regard
to geographic price differentials. A policy of freeing the consumer
price from government control combined with a policy of breaking
up present local monopolies in the wholesale trading of sugar
would probably result in a more economic distribution of sugar
and prevent monopoly pricing at the same time.

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CHAPTER II

THE SUGAR INDUSTRY IN EAST AFRICA

Sugar has been one of the two successful large scale plantation crops in East Africa, the other being sisal. Historically, East African production has tended to lag behind domestic consumption, though the industry will probably undergo a large scale expansion during the 1960's so that by the end of the decade, East Africa may have substantial sugar exports, perhaps about 100,000 tons. As a background to later analysis of the problems which might arise as a result of possible large scale expansion of the industry, we shall outline some of the characteristics of the sugar industry in the past including a discussion of the past trends in production, consumption, and trade; prices; methods of distribution; and the location of production.

A. Production, Consumption, and Trade

Most of the sugar produced in East Africa through 1964 has not been refined but has been a mill white sugar of varying quality. Thus, even if East Africa were to produce all of its requirements of mill white sugar in the future, small amounts of refined sugar and other speciality sugars may have to be imported to satisfy the limited demand for these products. In addition to the production of mill white sugar, small amounts of jaggery, a very crude sugar, are produced.

At present (1964), only Uganda produces substantially more sugar than is required for local consumption, but the Uganda surplus is not sufficient to cover the shortfall in Kenya. Thus East Africa taken as a whole is a net importer of sugar. Mill white sugar production, consumption, shortfalls, exports and imports for each of the three East African countries and for East Africa as a whole are shown in Table II-1. The difference between total imports (or exports) and total shortfall (or surplus) for each of the three countries and East Africa as a whole may be attributed to changes in stocks. The amounts produced by Uganda, Kenya, and Tanganyika as percentages of total East African production are 56, 16, and 28 per cent, respectively. The five largest producers (two in Uganda, one in Kenya, and two in Tanganyika) together

TABLE II·I

Sugar Production, Consumption and Trade in East Africa, 1964

	Uganda	Kenya	Tanga-nyika	East Africa
No. of Producers	2	2	5	9
Production ('000 long tons)	123.5	34.5	60.5	218.5
Consumption ('000 long tons)	83.2	103.5	57.8	244.5
Per Capita Consumption (lbs.)	25.3	25.5	13.0	20.8
Shortfall (consumption less production)	−40.3	69.0	−2.7	26.0
Exports to East African Countries ('000 long tons)	43.9	—	0.1	44.0
Imports from East African Countries ('000 long tons)	—	43.6	0.4	44.0
Exports Outside East Africa ('000 long tons)	0.4	—	0.4	0.8
Imports from Outside East Africa ('000 long tons)	—	29.0	—	29.0

Source: East African Common Services Organization.

TABLE II-2

Actual Production and Consumption of Sugar in East Africa, 1953-64
(long tons)

Year	Consumption Per Capita (lb.)	Consumption	Production	Shortfall
		UGANDA		
1953	15.5	38,761	47,973	−9,212
1954	19.5	50,137	40,813	9,324
1955	21.0	55,396	65,155	−9,759
1956	21.2	57,127	69,036	−11,909
1957	20.6	56,987	80,773	−23,786
1958	21.6	61,427	80,988	−19,561
1959	22.0	63,831	81,077	−17,246
1960	21.0	62,486	92,978	−30,492
1961	23.6	71,965	95,501	−23,536
1962	21.0	65,749	104,310	−38,561
1963	22.6	72,717	122,042	−49,325
1964	25.3	83,221	123,547	−40,326
		KENYA		
1953	15.8	46,475	16,612	29,863
1954	16.1	48,819	11,988	36,831
1955	17.3	54,087	16,601	37,486
1956	19.9	63,987	19,886	44,101
1957	20.4	67,695	20,026	47,669
1958	20.5	69,838	27,931	41,907
1959	22.0	77,155	27,210	49,945
1960	24.0	86,845	29,609	57,236
1961	24.7	92,015	32,606	59,409
1962	25.7	98,839	32,647	66,193
1963	24.5	96,632	37,086	59,546
1964	25.5	103,470	34,479	68,991

The Sugar Industry in East Africa

TANGANYIKA

1953	..	..	8.4	30,453	10,708	19,745
1954	..	..	9.1	33,853	10,734	23,119
1955	..	..	9.8	37,106	10,684	26,422
1956	..	..	10.3	39,481	17,905	21,576
1957	..	..	10.5	41,083	19,453	21,630
1958	..	..	10.2	40,615	21,243	19,372
1959	..	..	11.6	46,841	27,649	19,192
1960	..	..	12.0	49,650	28,730	20,920
1961	..	..	12.7	53,171	28,713	24,458
1962	..	..	13.5	57,704	36,880	20,824
1963	..	..	12.1	51,972	49,234	2,738
1964	..	..	13.0	57,820	60,470	-2,650

TOTAL EAST AFRICA

1953	..	..	12.7	115,689	75,293	40,306
1954	..	..	14.3	132,809	63,535	69,274
1955	..	..	15.4	146,589	92,440	54,149
1956	..	..	16.5	160,595	106,807	53,788
1957	..	..	16.6	165,765	120,252	45,513
1958	..	..	16.8	171,880	130,162	41,718
1959	..	..	17.9	187,827	135,936	51,891
1960	..	..	18.6	198,981	151,317	47,664
1961	..	..	19.8	217,150	156,820	60,330
1962	..	..	19.8	222,292	173,837	48,455
1963	..	..	18.7	221,321	208,362	12,959
1964	..	..	20.8	244,511	218,496	26,015

Source: East African Common Services Organization.

account for 94 per cent of total East African production.

Production and consumption for the East African countries is shown in a Table II-2 for the years 1953 to 1964. The average annual rates of increase of production between those years are 9.8 per cent for Uganda, 8.3 per cent for Kenya, 16.5 per cent for Tanganyika, and 10.7 per cent for East Africa as a whole. The large rate of increase in Tanganyika was in part due to a very large increase in production between 1962 and 1964 resulting from the opening of a new factory. Between 1953 and 1964, consumption has increased at an average annual rate of 6.5 per cent in Uganda, 7.6 per cent in Kenya, 5.6 per cent in Tanganyika, and 6.7 per cent for all of East Africa.

Despite the fact that production in East Africa has grown faster than consumption, there has been a consistent shortfall through the period 1954 to 1964 as shown in Tables II-1 and II-2.

B. Geographical Distribution of Consumption

Tables II-3 and II-4 give the estimated consumption by province for Kenya and by region and district for Uganda. The figures given in these tables are actual deliveries from the factories to

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wholesalers and retailers in the particular geographical areas. Thus the consumption figures will be somewhat overstated in the urban areas where there is a greater preponderance of wholesalers and larger stocks are held.   Some transfers take place from stocks

TABLE II-3

Kenya Sugar Consumption by Province, 1959

Province	Con-sump-tion (tons)	Per Cent of Total	Popula-tion (thou-sands)	Per Cent of Total	Per Capita Consum-ption (lbs.)
Nairobi Extra-Provincial District	13,720	17.9	287	3.6	107.1
Central	17,013	22.2	1,752	22.3	21.8
Nairobi and Central Province ..	30,733	40.1	2,039	25.9	33.8
Rift Valley	11,465	15.0	955	12.2	26.9
Nyanza	13,523	17.6	2,741	34.9	11.1
Southern	8,218	10.7	923	11.7	19.9
Coast (excluding Mombasa) ..	4,042	5.3	499	6.4	18.1
Mombasa	5,791	7.6	163	2.1	79.6
Mombasa and Coast Province ..	9,833	12.9	662	8.5	33.3
Northern	2,839	3.7	537	6.8	11.8
TOTAL ..	76,611*	100.0	7,858	100.0	21.8

*This total is about 500 tons different from that in Table II-2 since the two estimates were prepared independently and slight differences in definition may have been used.

Sources: Consumption data from Ministry of Commerce and Industry, Government of Kenya.   Population data from Government of Kenya, *Statistical Abstract 1963*, Nairobi, Government Printer, 1963, Table 13, p.8.   Population data from 1962 census have been adjusted by assuming a 3 per cent rate of population growth in all provinces to get 1959 population estimates.

in these urban areas to more remote areas, but the figures given in Tables II-3 and II-4 may be considered as rough approximations of consumption in the various geographical areas.

As can be seen from Tables II-3 and II-4 the consumption of sugar per capita varies significantly from region to region in Uganda and Kenya.   Similar and comparable data for Tanganyika are not available, but the little evidence there is points to the same wide disparities.   In Nairobi district per capita sugar consumption is extremely high, 107.1 lbs. (48.7 kilograms).   Mombasa per capita consumption is also high, 79.6 lbs. (36.2 kilograms).   Part of these

TABLE II-4

Uganda Sugar Consumption by Region and District, 1958

	Consump-tion (tons)	Per Cent of Grand Total	Popula-tion (thou-sands)	Per Cent of Grand Total	Per Capita Consu-mption (lbs.)
BUGANDA:					
Mengo	27,743	45.5	1,304	20.5	47.6
Masaka	4,736	7.8	433	6.8	24.5
Mubende	693	1.1	97	1.5	16.0
Total	33,173	54.4	1,834	28.8	40.5
EASTERN REGION:					
Busoga	11,848	19.4	660	10.4	40.2
Bugisu/Bukedi/Mbale/Sebei	5,683	9.3	748	11.7	17.0
Teso	2,347	3.8	447	7.0	11.8
Total	19,878	32.6	1,855	29.1	24.0
NORTHERN REGION:					
Lango	1,942	3.2	345	5.4	12.6
Acholi	1,316	2.2	280	4.4	10.5
Karomoja	270	0.4	168	2.6	3.6
West Nile/Madi	651	1.1	425	6.7	3.4
Total	4,180	6.9	1,218	19.1	7.7
WESTERN REGION:					
Bunyoro	1,232	2.0	125	2.0	22.1
Toro	1,215	2.0	341	5.4	8.0
Kigezi	564	0.9	482	7.6	2.6
Ankole	749	1.2	518	8.1	3.2
Total	3,760	6.2	1,466	23.0	5.7
GRAND TOTAL	60,991*	100.0	6,373	100.0	21.4

*This total is about 500 tons different from that in Table II-2 since the two estimates were prepared independently and slight differences in definition may have been used.

Sources: Consumption data from Ministry of Commerce and Industry, Uganda Government. Population figures are derived from Uganda Government, *Statistical Abstract 1963*, Entebbe, Government Printer, 1963, Table UB4, p.7. 1959 population figures were adjusted to get 1958 estimates by assuming a 2.5 per cent rate of growth in all districts.

high consumption estimates in Nairobi and Mombasa probably represents an upward bias because Nairobi and Mombasa act as distribution centres for the surrounding areas. If we lump Nairobi and Mombasa with Central and Coast Provinces, respectively, the per capita consumption estimates are 33.8 and 33.3 lbs. or nearly three times as high as the consumption of the Northern Province. In Uganda, Mengo district which includes Kampala, the capital and largest city, is exceptional with per capita consumption almost twice that in any other district of Uganda.

The 1959 estimated per capita incomes of Africans in the regions and districts of Uganda are shown in Table II-5. One may note that the high income areas are those with high per capita sugar consumption. The high income Buganda and Eastern regions account for 87.0 per cent of total sugar consumption even though these areas contain only 57.9 per cent of the population. The inequality of sugar consumption is even more

TABLE II-5

Income of African Households by District, 1959

UGANDA

	Cash Income Per Capita £	Subsistence Production Per Capita £	Cash Plus Subsistence Per Capita £
BUGANDA	19.3	7.0	26.3
EASTERN PROVINCE:			
Busoga	11.3	5.3	16.6
Bukedi	8.9	5.8	14.7
Bugisu	7.9	5.2	13.1
Teso	10.6	6.3	16.9
Mbale Township	18.0	—	18.0
TOTAL	10.0	5.6	15.6
NORTHERN PROVINCE:			
Karamoja	4.0	6.8	10.8
Lango	7.5	6.3	13.8
Acholi	4.8	5.9	10.7
West Nile and Madi	4.3	6.3	10.6
TOTAL	5.3	6.2	11.5
WESTERN PROVINCE:			
Bunyoro	12.8	6.8	19.6
Toro	8.6	7.0	15.6
Kigezi	2.9	6.2	9.1
Ankole	3.8	6.9	10.7
TOTAL	5.4	6.7	12.1
TOTAL UGANDA	10.7	6.4	17.1

Source: Uganda Protectorate, *The Gross Domestic Product of Uganda 1954-1959*, Entebbe, Government Printer, 1961, Table 31, p. 35.

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striking if it is considered that Mengo and Busoga districts alone account for about 65 per cent of total consumption of sugar but only about 31 per cent of the total population.

The same pattern is true of Kenya to a lesser extent. Nairobi and Mombasa, high income urban areas, alone account for over one-quarter of total sugar consumption in Kenya while containing only 5.7 per cent of the population. If we add the Central and Coast Provinces to Nairobi and Mombasa, we account for nearly 53 per cent of total sugar consumption but only about 34 per cent of the population.

The differences in sugar consumption are generally larger than the differences in income in the case of Uganda and one suspects the same is true in Kenya. This points to a very high income elasticity of demand with the range of per capita incomes existing in East Africa[1].

C. Analysis of Consumption by End Use

Sugar is used mainly in household consumption in East Africa. Industrial consumption at present is a small proportion of the total. The major industrial consumers of sugar in East Africa are the beer and soft drinks industry, the bakery products industry, and the chocolate and sugar confectionery industry.

According to the 1961 *Kenya Census of Manufacturing*, the beer and soft drinks industry of Kenya consumed £41,000 worth of sugar in 1961. The consumption of the bakery products industry is not given by the census, but total materials purchases is given as £1,280,000. Of this 85 per cent is specified as purchases of flour and packing materials and the remaining 15 per cent as purchases of fats, sugar, eggs, yeast, etc. If we assume that roughly 7.5 per cent of the purchases of materials by the bakery industry represents purchases of sugar, then the expenditure on sugar amounted to £96,075 in 1961. The total materials purchased by the chocolate and sugar confectionery industry in Kenya is given as £73,100, and "the greater part . . . represented sugar purchases."[2] Let us assume that 90 per cent or £65,790 represented sugar pur-

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1. More will be said about this in Chapter III in our discussion of the meaningfulness of elasticity estimates based on cross-section data.
2. Government of Kenya, *Kenya Census of Manufacturing*, 1961, Economics and Statistics Division, Ministry of Finance and Economic Planning, December 1963, pp. 22, 24 and 27.

chases. If we further assume that the price of sugar to the industrial users averaged about £50 per ton, then the amount of sugar consumed by the three main industrial users in Kenya in 1961 was as follows:—

Beer and soft drinks	.. .. ..	820	tons
Chocolate and sugar confectionery	..	1,316	,,
Bakery products	.. ..	1,922	,,
	Total ..	4,058	tons

The estimated 4,058 tons of industrial consumption represents 4.4 per cent of the total Kenya consumption for the year 1961.

In Tanganyika, the purchases of sugar by the beer and soft drinks industry and by the bakery products industry were £42,971 and £2,213, respectively, in 1961. The 1961 *Tanganyika Census of Industrial Production* does not give the purchases of sugar by the chocolate and confectionery industry in Tanganyika, but total output is specified in the area of £30,000[3]. Applying the ratio of sugar purchases (in tons) to the value of output of the chocolate and sugar confectionery industry in Kenya for 1961[4], one obtains an estimate of sugar purchases of £16,050. Again assuming an average price of £50, the consumption of sugar by the three main consuming industries in Tanganyika was as follows in 1961:

Beer and soft drinks	.. .. ..	860	tons
Chocolate and sugar confectionery	..	321	,,
Bakery products	.. ..	44	,,
	Total ..	1,225	tons

The estimated industrial consumption of sugar in 1961 represents 2.3 per cent of the total consumption for that year.

No industrial census has been conducted for Uganda. Thus comparable estimates of the industrial use of sugar are not available. Uganda has both a biscuit industry and a substantial sugar confectionery industry and exports both bakery products and sugar

3. Republic of Tanganyika and Zanzibar, *Census of Industrial Production in Tanganyika, 1961,* Central Statistical Bureau, Dar es Salaam, 1964, pp. 41, 44, 45.

4. The total output of the chocolate and sugar confectionery industry in Kenya was £123,000 in 1961. The ratio of sugar purchases (in tons) to value of output was .535. See Government of Kenya, *op. cit.,* Appendix, Table 1.

confectionery to both Kenya and Tanganyika. It is doubtful, however, whether Uganda's industrial consumption is any larger than that of Kenya.

The total industrial consumption in East Africa is probably in the range of three to five per cent of total consumption. This percentage should grow in the future as incomes grow since bakery products, soft drinks, and sweets are relative luxury items for a country at East Africa's stage of development.

D. Indirect Imports of Sugar

None of the consumption estimates given above contain estimates of indirect consumption through importation of products containing sugar. Table II-6 gives the imports from outside of East Africa of beer and soft drinks, bakery products, and chocolate and sugar confectionery products for the year 1961. The sugar content of these imports may be estimated very roughly by applying the ratios of sugar consumption (in tons) to the value of output for each

TABLE II-6
Net Imports of Certain Products from Outside East Africa into Kenya, Uganda, and Tanganyika, 1961
(£'000)

	Kenya	Uganda	Tanganyika
Beer and Soft Drinks	74.5	26.6	74.2
Chocolate and Sugar Confectionery ..	308.2	82.1	128.5
Bakery Products	43.1	7.5	21.5

Source: East African Common Services Organization, East African Customs and Excise, *Annual Trade Report of Kenya, Uganda, and Tanganyika* for the year ended 31st December, 1961, Mombasa, Commissioner of Customs and Excise, pp. 16-17, 20-21, and 8.

of the three industries in Kenya and Tanganyika.[5] The resulting

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5. The value of output of the three industries and the ratios of sugar consumption (in tons) to the value of output in Kenya and Tanganyika for 1961 are as follows:

	Kenya		Tanganyika	
	Value of output excluding excise (£'000)	Ratio of sugar consumption to value of output (tons/£'000)	Value of output excluding excise (£'000)	Ratio of sugar consumption to value of output (tons/£'000)
Beer and soft drinks	3,704	0.221	1,206	0.713
Chocolate and sugar confectionery	123	10.699	30	10.700
Bakery products	1,870	1.028	329	0.134

See Government of Kenya, *op. cit.*, Appendix, Table 1, and Republic of Tanganyika and Zanzibar, *op. cit.*, pp. 41, 44, and 45. The large differences between the ratios of Kenya and Tanganyika for beer and soft drinks and

TABLE II-8

World Sugar Prices, 1955-63

(Price per ton of raw sugar in the Caribbean—unit values of the period or average of monthly quotations during the period).

1955	..	..	£26		1963		
1956	..	..	28				
1957	..	..	41	Jan.	£44	July	£73
1958	..	..	28	Feb.	48	Aug.	54
1959	..	..	24	Mar.	53	Sept.	59
1960	..	..	25	Apr.	61	Oct.	82
1961	..	..	23	May	84	Nov.	93
1962	..	..	24	June	79	Dec.	85

Source: *International Financial Statistics*, Washington, D.C.,The International Monetary Fund, Volume XVI, Number 9; Volume XVII, Numbers 5, 7, 9 and 10.

substantially above the East African producer price, the Kenya and Tanganyika governments imported sugar to make up for their shortfalls, paying the very high world price and selling at a price commensurate with the East African internal prices. Substantial losses were made in these transactions. The world price of sugar fell very quickly, however, from its November 1963 high point of £105 per ton (c.i.f. London). The price fell steadily throughout most of 1964 and reached a low of £21 per ton (c.i.f. London) in February 1965[6].

The manner in which sugar is distributed differs from territory to territory. In Kenya, the entire distribution is handled by the Ministry of Commerce and Industry. Every month the Ministry sends out directives to the two sugar mills telling them how much to ship to each station on the rail line. The Ministry pays each factory the East African producer price less excise plus its estimate of the average transport cost to each point along the rail line. The factories keep track of the actual transport costs involved and either receive an extra allowance if transport costs exceed the Ministry's estimates or must pay back the difference if transport costs are less than the Ministry's estimates. The government then sells the sugar at each rail station to a government appointed sub-agent. The price is the same to each sub-agent at each point along the rail line. There are four government appointed main agents who act as bookkeepers and collection agents from the sub-agents for the government. They are paid a small commission.

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6. See *Financial Times*, London, January 2, 1965, p.2 and February 6, 1965, p.2·

The sub-agents may then sell to wholesalers or to government appointed local sub-agents. The maximum price at which the sub-agents may sell to local sub-agents and wholesalers is fixed by law as is the wholesale price and the retail price.[7] The difference between the sub-agents buying price and the retail price is sufficient to cover the cost of transport and handling from the railhead to the point of consumption and to cover a small commission for the sub-agent, the wholesaler or government appointed sub-agent, and the retailer. The government does not have an elaborate inspection system to enforce the legal wholesale and retail prices so it is questionable as to whether the retail and wholesale prices of sugar are as specified by law.

In 1964, the two major Tanganyika manufacturers each had contracts with marketing firms to handle the distribution of their sugar. The Tanganyika Planting Company at Arusha Chini had a contract with Marco Surveys Limited. Marco Surveys bought the sugar from the factory and sold to its agents at each point along the rail line. The price to the agent was sufficient to cover the transport cost plus a commission for Marco Surveys. Thus, in contrast to Kenya, prices differed along the rail line according to differences in transport costs. Wholesale and retail prices were suggested by Marco Surveys. The Kilombero Sugar factory had nearly the same distribution arrangements with the International Trading and Credit Company of Tanganyika Limited, otherwise known as Intrata. Intrata hired inspectors to check at each point in the distribution chain to see that wholesalers and retailers did not sell at prices different from the prices specified by Intrata. The wholesale and retail prices were not fixed by law in Tanganyika, but the Ministry of Commerce and Industry specified a set of reasonable prices in each area based on the Ministry's estimates of transport costs and reasonable distribution margins. If the Ministry heard of any divergency from these prices the trader was given a warning by a local government official which usually kept the trader in line. The three smaller sugar firms in Tanganyika did not have such elaborate distribution systems but rather sold at the factory to traders who were willing to supply their own transport. In 1965, the whole method of sugar distribution was being revised

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7. See the *Laws of Kenya*, Price Control Ordinance, Chapter 504, Subsidiary Legislation, Orders under Section 5.

to bring it under control of a government appointed marketing board.

The distribution system in Uganda is similar to the one in Tanganyika prior to the 1965 reorganization. The two sugar producers have contracts for distribution by other firms. While retail prices are not fixed by law in Uganda, the Ministry of Commerce has a suggested price in each area of the country based on estimates of transport costs from the nearest factory and reasonable distribution margins. In all three countries the agents who are appointed by the government in Kenya and the distributing firms in Uganda and Tanganyika are required to keep one month's reserve stocks to forestall disruptions in the flow of sugar to the consumer due to unevenness in production schedules, floods, strikes and so forth.

The average price to the consumer in East Africa is about 50 per cent higher than the factory price. The difference is attributable to transportation, handling, excise taxes, production cesses, and

TABLE II-9
Retail Prices and Per Capita Consumption in Selected Sugar Producing Countries, 1957

Country	Retail Price (U.S. cents per kilogram)	Per Capita Consumption (kilograms)
British Guiana	9.6	41.2
Mauritius	9.7	38.7
Argentina	12.0	40.0
Trinidad	12.5	36.3
Barbados	14.1	47.8
Brazil	16.9	33.8
Haiti	17.6	10.2
Jamaica	18.6	36.2
Kenya	18.8	9.3
Cuba	19.7	47.4
Philippines	20.0	11.7
Uganda	20.4	9.4
Tanganyika	21.6	4.8
Netherlands	23.2	41.2
Hong Kong	24.7	20.0
Bahamas	25.7	26.3

Source: A. Viton and F. Pignalosa, *Trends and Forces of World Sugar Consumption*, Food and Agricultural Organization of the United Nations, Rome, 1961, pp. 18 and 54.

marketing. costs For sake of comparison, among 78 contries consider by Viton and Pignalosa, 35 had lower retail prices in 1957 than the average retail price in Uganda while 42 had higher

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prices.[8]   The median retail price was 22.5 U.S. cents per kilogram while the Uganda price was 20.4.   Compared with 16 sugar producing countries, however, the retail price in East Africa is relatively high (see Table II-9).

TABLE II-10
Retail Price of Sugar, East Africa, 1954-63

Year				Uganda (Kampala)	Kenya (Nairobi)	Tanganyika (Dar es Salaam)
1954	..	..	..	52	58	55
1955	..	..	..	57	61	60
1956	..	..	..	54	56	65
1957	..	..	..	65	65	70
1958	..	..	..	60	58	60
1959	..	..	..	60	59	60
1960	..	..	..	60	59	60
1961	..	..	..	60	62	59
1962	..	..	..	63	65	64
1963		..	..	63	67	

Sources: Uganda Government, *Statistical Abstract* (Annual);   Government of Kenya, Statistical Abstract (Annual); and Government of Tanganyika, *Statistical Abstract* (Annual) for the years 1954 to 1962 for Uganda and Tanganyika and to 1963 for Kenya. The 1963 price for Uganda supplied by the East African Common Services Organization, The Treasury.

The retail sugar prices in Table II-10 refer to prices in the urban centres of the three East African countries.   They indicate a similar pattern of change.   This has been due mostly to similar changes in the excise duty on sugar (See Table II-11).   Retail prices in rural

TABLE II-11
Sugar Excise Duty, Uganda, 1946-64
(Sugar excise duties have been the same in Kenya and Tanganyika as those in Uganda except for very brief periods).

From	To	Duty per Cwt. (112 pounds)		Duty Per Pound	
1946	April, 1954	Shs.	2/24	Shs.	/02
April, 1954	May, 1957		5/60		/05
May, 1957	Jan., 1958		16/80		/15
Jan., 1958	May, 1958		15/14		/13.5
May, 1958	May, 1961		8/96		/08
May, 1961	July, 1962		12/32		/11
July, 1962	June, 1963		15/68		/14
June, 1963	June, 1965		17/92		/16

Sources: *Laws of Uganda*—1953, Ordinance No. 18;
1954, Ordinance No. 9; 1957, Ordinance No. 12;
1958, Ordinance Nos. 10 and 25; 1961, Ordinance No. 10;
1962, Ordinance No. 41; 1963, Act No. 40.

8. A. Viton and F. Pignalosa, *Trends and Forces of World Sugar Consumption*, Food and Agricultural Organization of the United Nations, Rome, 1961, p. 18.

areas differ from those in the urban centres by an amount depending on the distance from the nearest sugar factory, or, in the case of Kenya, depending on the distance from the nearest rail head; however, increases and decreases in rural retail prices correspond in magnitude and occur simultaneously with those in the urban centres.

F. The Location of the Sugar Industry in East Africa

The locations of the nine centrifugal sugar mills existing in East Africa in 1964 are shown on the map in the back of this volume. Two of the mills are in Uganda, both near Jinja. These mills, the two largest in East Africa, are located near the markets of the relatively wealthy and heavily populated Uganda districts of Bukedi, Bugisu, Busoga, and Mengo. The annual output of these two plants, however, well exceeds the consumption in these areas. The rainfall in the areas occupied by the plantations of the two Uganda sugar mills is bi-modal (April and November) but fairly well distributed throughout the year and averages from 50 to 55 inches (see Stations 89.33027 and 89.32015-13 in Table II-12). Average yields for estate grown cane are about 45 tons of cane per acre harvested without irrigation. Rainfall probability of failure to reach 30 inches is less than 5 per cent on all parts of the Uganda estates.[9] Some of the fields are irrigated with water from Lake Victoria and the resulting yields are 50 to 100 per cent greater than without irrigation. The topography is hilly so that expensive overhead irrigation is required. The hilly topography also introduces problems into cultivation and harvesting and would make mechanical harvesting difficult. The two Uganda estates have well drained and fertile soils and "could not be better situated as far as soils go."[10] The altitude of these plantations is low enough (about 3800 feet) so that the average temperature is well above 68 degrees Fahrenheit, the temperature above which abundant cane growth occurs.[11] The lack of sunshine results in a fairly long maturation period for the cane, 17 to 20 months.

9. See map of rainfall probability in *East Africa Royal Commission 1953-1955 Report*, London, Her Majesty's Stationery Office, 1955.

10. E. M. Chenery, *An Introduction to the Soils of the Uganda Protectorate*, Dept. of Agriculture, Memoirs of the Research Division, Series 1, No. 1, Kampala, 1960, p.50.

11. *The World Sugar Economy—Structure and Policies*, Vol. 1, London, The International Sugar Council, 1963, p.61.

TABLE II-12

Rainfall at Selected Points in or near Sugar Growing Areas of East Africa

East African Meteorological Station No.	Name			Altitude	Average Annual Rainfall* (inches)	No. of Years
96.37018	Mhonda Mission	..	..	1600	70.0	19–20
94.39004	Gazi	..	..	Nil	54.1	40–43
94.39003	Ramisi	..	..	Nil	54.6	33–36
93.37028	Arusha Chini	..	..	2300	16.5	24–25
91.31002	Bukoba	..	..	3753	80.6	42–43
90.35047	Chemelil Station	..	..	4034	52.0	26–27
90.35016	Muhoroni Station	..	..	4265	60.1	58–59
90.34013	Miwani, Section II	..	..	4000	52.8	27–28
90.34012	Miwani, Section I	..	..	4000	55.3	27–28
90.34008	Miwani, The Mill	..	..	3959	53.4	39–40
90.34004	Kisumu, Civil Secretary's Office			3759	44.1	59–60
90.34002	Miwani Station	..	..	4000	46.7	31
90.31002	Sango Bay	..	..	3900	47.5	31–35
89.33027	Mutai Forest Station	..	..	3760	53.2	22–23
89.32015	Nagoje Estate	..	..	3780	53.6	38–39
89.32013	Moniko Estate	..	..	4100	56.3	48–49

* Computed by summing monthly averages including latest available data up to June 1964.

Source: *The Daily Rainfall of East Africa*, Nairobi, East African Meteorological Department, 1961, 1962, 1963, and 1964.

One of the Kenya producers is near the coast at Ramisi and the other is near the shores of Lake Victoria at Miwani. Conditions are vastly different in these two locations. Cane grown near the coast ripens fast (12 to 14 months) because of abundant sunshine and high temperatures, but yields are low, in the area of 15 tons per acre. Rainfall at the Ramisi plantation varies considerably depending on distance from the ocean. On the inland parts of the estate rainfall is less than 50 inches while near the coast the average is close to 55 (see Stations 94.39004 and 94.39003 in Table II-12).[12] Rainfall is poorly distributed, falling mostly in April, May, and June, and the probability of less than 30 inches in parts of the area is 5 to 15 per cent.[13] The uncertain, poorly distributed rainfall coupled with thin porous soils mean that the cane growth is inhibited by lack of water.

In the Miwani area of Kenya, average actual yields for estate grown cane are about 30 to 35 tons per acre harvested. The growing season, however, is longer than that at Ramisi, averaging 20 to 22 months. At Miwani, most cane is grown under two different

12. See *Atlas of Kenya*, Nairobi, The Survey of Kenya, 1962, p.12 for a map showing average rainfall.
13. See the rainfall probability map in *East Africa Royal Commission 1953-1955 Report*, Op.cit.

types of conditions. At the lower altitudes (about 4000 feet) in the relatively flat valley of the Nyando River and its tributaries, black cotton soils, poorly drained[14] and susceptible to weed growth, predominate. Rainfall is well distributed throughout the year and ranges from about 45 inches to about 55 inches (see Stations 90.35047, 90.34013, 90.34012, 90.34008, 90.34004, and 90.34002 in Table II-12), generally rising with altitude and distance from Lake Victoria[15]. The probability of failing to reach 30 inches is 5 to 15 per cent in much of the area nearer the lake[16]. Temperatures are relatively high and give good growth. Other cane is grown on the slopes leading up to the Nandi escarpment and in the upper parts of the valley of the Nyando River. The higher altitude means both higher rainfall (See Station 90.35016 in Table II-12) and lower temperatures. The night-time temperatures are low enough to inhibit cane growth, but the soils are sandy loams well drained and relatively weed free.

The plantation at Chemelil which supplies Miwani sugar mill with cane, has irrigated experimental plots with water from the Mbogo River, giving yields nearly double the average yields for rain grown cane[17]. Cane smut disease is generally regarded as endemic in the Miwani area[18].

The coastal factory at Ramisi is well situated with respect to the Mombasa, Voi, Tanga, and export markets. Transport costs to the heavily populated Central and Nyanza Provinces of Kenya are much higher. The Miwani mill has good access to the heavily populated Nyanza Province and the wealthy Rift Valley Province.

There are two sugar mills in northern Tanganyika, one large and one very small. The large plantation at Arusha Chini is situated on very flat land with thick volcanic soils of high salinity

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14. Poor drainage caused by low porosity soils results in water logged cane and impedes growth. A very high soil porosity, on the other hand, may mean that water runs off too fast and cane growth is inhibited by lack of water.

15. See rainfall map in *Atlas of Kenya, op. cit.,* p.12.

16. See rainfall probability map in *East Africa Royal Commission 1953-1955 Report, op. cit.*

17. Colony and Protectorate of Kenya, *Soil Survey of the Songhor Area, Kenya,* Nairobi, Government Printer, 1960, p.14.

18. Uganda Department of Agriculture, *Report of a Visit by the Plant Pathologist to Sango Bay Sugar Estate,* 11th-13th December, 1963, p.3 and C.L.A. Leaky, *Diseases of Sugar Cane in Uganda,* Uganda Department of Agriculture, Technical Communication No. 7, (no date), p. 3.

and good porosity[19]. Rainfall is very low, about 17 inches per annum on the average (see Station 93.37028 in Table II-12), and furrow irrigation is practised, using plastic pipes to bring water from the Weru-Weru River. The altitude is somewhat over 2000 feet, and although temperatures are sufficiently high for good cane growth, the lack of sunshine results in an 18 to 20 month period for the maturation of cane. Average output of cane per acre is very high, over 75 tons per acre harvested. The high yields are largely attributable to very carefully controlled water application through irrigation.

Of the two factories in the western part of the Eastern Province of Tanganyika, one is very large and the other is quite small. The large manufacturer at Kilombero began its first grinding of cane in mid-march of 1962. The soils of the Kilombero plantation are alluvial clay loams which are of good porosity. All cane is irrigated by an over-head system. Although rainfall in parts of the plantation is probably from 50 to 60 inches per annum, it falls mainly during the period from December through May. The months from June through November are very dry and irrigation is necessary to stimulate growth during that period. The altitude is low, about 1000 feet, and the high temperature and sunny dry period enable the cane to ripen in about 14 months. At the small sugar plantation near Turiani rainfall is quite high (see Station 96.37018 in Table II-12) and the altitude low.

The only other sugar mill in Tanganyika is a rather small one near Bukoba. Rainfall varies on the plantation, increasing towards the direction of Bukoba[20]. At the far end of the estate annual rainfall probably averages close to 50 inches while at Bukoba it reaches about 80 inches per annum (see Station 91.31047 in Table II-12). Yields of cane are about 25 tons per acre harvested. Cane smut disease is a problem in the area[21].

The factory at Arusha Chini in Tanganyika is well situated with respect to the wealthy Northern and populous Tanga Provinces. The Kilombero factory is close to the heavily populated areas of

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19. Saline soils affect the capacity of the cane to draw up water from the ground by osmosis. Cane, however, is more resistant than most plant crops to saline soils.

20. See rainfall map in *Atlas of Tanganyika*, 3rd edition, Dar es Salaam, Survey Division of Department of Lands and Surveys, 1956, p.5.

21. See Footnote 18.

the Eastern, Central, and Southern Highlands Provinces. Both factories are far from the heavily populated Lake and West Lake Provinces of Tanganyika. The mill near Bukoba does not produce enough sugar to supply these provinces. The Uganda and Kenya mills in the Lake Victoria basin have easier access across the lake to these provinces than the two Tanganyika factories at Arusha Chini and Kilombero.

Two factories were in the construction stage in 1964, one at Sango Bay in Uganda and one at Muhoroni in Kenya. Both were scheduled to begin grinding sometime in 1965. The Muhoroni factory will operate primarily by crushing outgrower cane, much of which is now being produced and used in the production of jaggery. The Sango Bay plantation lies in a swampy area on the shore of Lake Victoria. The soils are heavy clays and give poor drainage. A large network of drainage canals has been dug to prevent flooding. These drainage canals may prove useful for irrigation purposes as the average rainfall of 46 inches is on the low side for good cane growth. Certain areas of the estate, however, have a higher rainfall.[22] The Bukura River and its tributaries have a sufficient flow to provide water to irrigate nearly all the cane. Yield data at Sango Bay is not yet available.

Several new factories have been proposed or are under active consideration for East Africa. A factory was proposed at Wami River in Tanganyika to produce raw sugar for export from cane grown on the Wami River irrigation project. The Chemilil proposed project in Kenya would use a large proportion of outgrower cane and would constitute the third factory in the area. The proposed site at Mumias in Kenya is at a higher elevation than the sugar growing area near Miwani. The low temperatures make Mumias less attractive as a cane growing area.[23] The proposed project in southern Busoga district of Uganda if pursued would involve growing cane in an area which is at present heavily infested with tsetse fly. The clearing of the area for cane cultivation would automatically eliminate the tsetse fly by depriving the fly of the small scrub plants on which it depends. The area has a high average rainfall, in the range of 60 inches per annum. Rain grown

22. See *Atlas of Uganda*, First Edition, Department of Lands and Surveys, Uganda, Kampala, 1962, for rainfall map.

23. *East African Trade and Industry*, Vol. X, No. 127, September 1964, in a report of a speech by the Kenya Minister of Agriculture, p. 21.

cane yields should be good although the cane will be long in reaching maturity. In addition several other areas have been considered as possible sites but concrete plans are few.

The daily grinding capacities of the three countries of Uganda, Kenya, and Tanganyika are 600, 190, and 346 tons of sugar, respectively, and the total for East Africa is 1136 tons of sugar. Estimated annual grinding capacities are 172,500, 56,000, and 84,000 long tons, respectively, giving a total of 312,500 tons. The daily grinding capacity of Tanganyika overstates its annual grinding capacity relative to the other two countries because the harvesting season in Tanganyika is somewhat shorter. Nearly all the cane in Tanganyika is irrigated. Virtually none of the cane in Kenya is irrigated. About 15 per cent of the cane grown for sugar milling in Uganda is irrigated. Of all cane grown for sugar milling in East Africa about 30 per cent is irrigated.

CHAPTER III

ANALYSIS AND PROJECTION OF DEMAND

The purpose of this chapter is to attempt to measure the effects of various variables on sugar consumption in East Africa and to project consumption to 1970 by an analysis of time series data. The study was prompted by several policy considerations. Tanganyika and Kenya in their published plans for the years 1964-69 and 1964-70, respectively, have indicated a substantial increase in sugar production,[1] and one sugar factory is under construction and there have been tentative plans for four more in Uganda. At present East Africa is nearly self-sufficient in sugar production, and the substantial increase in production envisioned by 1970 will involve a large exportable surplus, perhaps about 100,000 tons. At present East Africa has a 10,000 ton quota under the Commonwealth Sugar Agreement, and marketing arrangements must be made for the balance of exports. The magnitude of the problem depends on how fast internal consumption can be expected to grow. Uganda now has a large exportable surplus, and the problem of marketing will be particularly acute for Uganda manufacturers. Suggestions have been made concerning various ways to stimulate internal consumption, among them a proposal for lowering the price to the consumer. An analysis of the effect of price on consumption could aid in determining whether such a policy would be effective.

The economic literature is filled with attempts to measure demand and supply elasticities using time series data for the more developed economies. To the author's knowledge no such attempt has been made using East African data. The analysis of sugar consumption in this paper illustrates the many problems which are likely to arise in an analysis of the consumption of any commodity in East Africa. The major problems occur because of the limited choice

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1. See Government of Kenya, *Development Plan 1964-1970*, Nairobi, Government Printer, 1964, pp. 51-52 and The United Republic of Tanganyika and Zanzibar, *Tanganyika Five Year Plan for Economic and Social Development, 1st July 1964-30th June, 1969*, Volume I, Dar es Salaam, Government Printer, 1964, p.26.

of different types of price indices, the unreliability of data, and the relatively short span of time for which any consistent time series are available. Two conspicuous constraints on many types of analysis are the lack of a consistent series for Gross Domestic Product before 1954 and the lack of any series for disposable income for any of the East African countries.

The demand for sugar in East Africa is more amenable to statistical analysis than the demand for many other commodities in East Africa because of the existence of a fairly reliable series on consumption and because of the nature of the supply function. In East Africa the supply of sugar effectively has been perfectly elastic with respect to price. The governments have usually stood ready to import sugar from outside of East Africa and sell it in the local market at the prevailing (fixed) internal price. Thus all changes in consumption can be attributed to factors affecting the demand schedule for sugar consumption.[2]

The factors affecting the demand for sugar can be grouped into three categories: (1) disposable incomes, (2) the retail price of sugar, and (3) miscellaneous factors which result in a rising time trend of sugar consumption. Despite the fact that data on these factors are sparse and cover only a relatively short period of time, it was felt that a useful attempt could be made to measure the strength and relative effects of the various factors affecting sugar consumption.

A. The Data and the Model

The data on sugar consumption are shown in Table II-2 of the previous chapter. The Gross Domestic Product at factor cost for the East African countries for the years 1954-63 is shown in Table III-1. In order to arrive at disposable income we subtracted all direct taxes, import duties, and excise taxes from Gross Domestic Product at factor cost. The justification for subtracting export and import duties is that these duties have their incidence directly upon the consumer, and thus theoretically must be regarded as having a similar effect on consumption patterns as direct taxes. In the case of import duties, it is generally true that the world supply of exports is in elastic supply with respect to the relatively small

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2. Technically, this means that the sugar demand schedule for East Africa is identifiable. See T. C. Koopmans, "Identification Problems in Economic Model Construction," *Econometrica*, Vol. 17 (1949), pp. 125-144.

TABLE III-1a

Price and Income Data, Uganda, 1954-63

Year	Gross Domestic Product a (£ mill.)	Disposable Income b (£ mill.)	Retail Price Index	Deflated Disposable Income (£ mill.)	Population ('000)	Disposable Income Per Capita (£)		Retail Sugar Price (cents)	
						Deflated	Non-Deflated	Deflated	Non-Deflated
1954	128.73	119.71	139	86.12	5,749	14.98	20.82	37	52
'55	140.18	129.79	115	112.85	5,895	19.14	22.01	50	57
'56	141.58	131.11	113	116.03	6,045	19.19	21.69	48	54
'57	146.72	136.20	103	132.23	6,190	21.33	21.97	63	65
1958	146.39	134.67	103	130.75	6,356	19.80	21.19	56	60
'59	148.97	136.61	107	127.67	6,513	19.60	20.97	56	60
'60	152.12	139.12	98	141.96	6,657	21.26	20.84	61	60
'61	157.33	143.97	123	117.05	6,845	17.10	21.03	49	60
'62	156.71	142.97	98	145.89	7,016	20.79	20.23	64	63
'63	176.10*	158.12*	100	158.12	7,190	21.99	21.99	63	63

TABLE III-1b

Price and Income Data, Kenya, 1954-63

Year	Gross Domestic Product a (£ mill.)	Disposable Income b (£ mill.)	Retail Price Index	Deflated Disposable Income (£ mill.)	Population ('000)	Disposable Income Per Capita (£) Deflated	Non-Deflated	Retail Sugar Price (cents) Deflated	Non-Deflated
1954	158.02	140.25	90	168.37	6,783	22.97	20.68	70	58
1955	180.54	160.14	95	181.98	6,993	26.02	22.90	69	61
1956	193.15	171.42	97	190.89	7,200	26.43	23.78	62	56
1957	205.91	184.32	100	199.05	7,432	26.67	24.80	70	65
1958	208.10	185.52	100	200.34	7,652	26.11	24.24	62	58
1959	214.79	191.60	101	204.92	7,880	25.87	24.31	63	59
1960	225.51	203.06	103	213.74	8,115	26.34	25.02	62	59
1961	224.70	201.90	105	208.14	8,353	24.92	24.17	64	62
1962	244.09	219.10	108	219.10	8,595	25.49	25.49	65	65
1963	259.96*	233.73*	108	233.73	8,847	26.42	26.42	67	67

TABLE III-1c

Price and Income Data, Tanganyika, 1954-63

Year	Gross Domestic Product a (£ mill.)	Disposable Income b (£ mill.)	Retail Price Index	Deflated Disposable Income (£ mill.)	Population ('000)	Disposable Income Per Capita (£) Deflated	Non-Deflated	Retail Sugar Price (cents) Deflated	Non-Deflated
1954	141.65	129.17	114	143.8	8,304	16.20	15.56	57	55
1955	146.74	133.89	113	150.6	8,454	16.68	15.85	63	60
1956	152.42	141.55	111	162.0	8,605	17.69	16.45	70	65
1957	162.36	150.90	119	161.0	8,759	17.23	17.23	70	70
1958	167.09	155.28	125	157.8	8,916	16.59	17.42	57	60
1959	177.11	164.14	116	179.8	9,076	18.64	18.09	62	60
1960	186.22	172.46	127	172.5	9,237	17.45	18.67	56	60
1961	188.66	174.88	126	176.3	9,421	17.51	18.56	56	59
1962	203.28*	188.07*	127	188.1	9,607	18.30	19.58	60	64

NOTES AND SOURCES TO TABLE III-1

A. *Notes:*

    a Monetary and Non-monetary Gross Domestic Product at Factor Cost.

    b Obtained by subtracting direct taxes, import duties, and export duties from GDP. Since the fiscal year in all three East African countries runs from July to June, it was assumed that the amount collected during each of the calendar years spanned by a fiscal year was one half of that collected during the fiscal year.

    * Provisional estimates.

B. *Sources:*

    (1) Retail price indices from the *Economic and Statistical Review* (Quarterly), Table G.2.

    (2) Retail sugar prices for 1963 supplied by the East African Common Services Organization, The Treasury.

    (3) Tanganyika estimates of Gross Domestic Product, export and import duties and direct taxes for 1961 and 1962 from Government of Tanganyika, *Budget Survey 1963-1964*, Dar es Salaam, Government Printer, 1963, pp. 3 and 20.

    (4) Kenya estimates of Gross Domestic Product, export taxes, direct taxes, and import duties for 1962 and 1963 from Government of Kenya, *Economic Survey 1964*, Nairobi, Government Printer, 1964, pp. 5 and 50.

    (5) Uganda estimates of Gross Domestic Product, export taxes, import duties and direct taxes for 1962 and 1963 from Uganda Government, *Background to the Budget, 1964-65*, Entebbe, Government Printer, 1964, pp. 1 and 40.

    (6) All other data for Uganda from Uganda Government, *Statistical Abstract* (Annual), Tables UB2, UM9, UN2, and UO4.

    (7) All other data for Kenya from Government of Kenya, *Statistical Abstract* (Annual), Tables 12, 124(*a*), 131 (*a*), and 136.

    (8) All other data for Tanganyika from Government of Tanganyika, *Statistical Abstract* (Annual), Tables C.2, P.1, P.17. Q.1, and R.2.

East African market while demand tends to be relatively inelastic with respect to price. With exports it seems reasonable to assume that the overall supply of exports is relatively inelastic with respect to price (although the supply of individual export commodities may not be so) and that demand is relatively elastic, the price of exports being set in most cases by the world market, independently of East African supplies.

One should also subtract corporate savings and depreciation and net transfer payments by households from Gross Domestic Product at factor cost in calculating disposable income. Unfortunately, however, no reliable data on the magnitude of these items exist, and they were not taken into account.

The disposable income estimate should be deflated by some sort of price index to arrive at an estimate of *real* disposable income. The only appropriate price indices which are available are:

    (1) The cost of living index (excluding rent): Kampala;

    (2) The index of retail prices in African markets: Kampala;

(3) The price index for Gross Domestic Product at factor cost: Uganda;[3]

(4) The cost of living index (excluding rent): Nairobi;

(5) The wage earner's index of consumer prices (retail price index): Nairobi;

(6) The wage adjustment index: Nairobi;

(7) The cost of living index (excluding rent): Dar es Salaam; and

(8) The retail price index of goods consumed by wage earners in Dar es Salaam.

The disposable income estimates were not deflated by the cost of living indices ((1), (4), and (7) above) nor by the wage adjustment index ((6) above)—which is merely the Nairobi cost of living index with the effects of price increases on alcohol and tobacco removed— because much of the rise in these indices may be attributed to increased import duties and to a rise in the cost of services. Since the effects of import duties on disposable income are taken into account by subtracting duties from gross domestic product at factor cost, it would not be appropriate to further deflate income by this factor. The calculation of the cost of living indices does not allow for changes in the quality of services although much of the rise in the cost of these services may be attributed to improvements in quality. For these reasons, the cost of living indices would tend to over-deflate disposable income. Another objection to the cost of living indices is that they are based largely on the expenditure pattern of middle income range European civil servants. The bulk of the income earned in Uganda and Tanganyika is earned by peasant farmers with very different expenditure behaviour.

The Uganda price index for Gross Domestic Product at factor cost would be inappropriate since it is heavily weighted to show the changes in export prices. In view of these difficulties with the various other price indices, we elected to use the retail price indices in Kampala, Nairobi, and Dar es Salaam for the respective countries of Uganda, Kenya, and Tanganyika. These indices, shown in Table III-1 are heavily weighted in favour of locally produced food crops. One of the disadvantages of these indices is that they measure urban retail price fluctuations which may not reflect rural

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3. See Uganda Government, *The Real Growth of the Economy of Uganda, 1954-1962*, Entebbe, Government Printer, 1964, p.46 for the price index for Gross Domestic Product at factor cost. All other indices are contained in the *Statistical Abstracts* of the respective countries.

price changes. In view of these difficulties, we decided to calculate estimates of both deflated and non-deflated disposable incomes. These are also shown in Table III-1.

The retail prices of sugar in the urban centres, Kampala, Nairobi, and Dar es Salaam, of the three East African countries are shown in Table III-1. Retail prices in rural areas differ from those in the urban centres by an amount depending on the distance from the nearest sugar factory or, in the case of Kenya, depending on the distance from the nearest railhead, but increases and decreases in rural retail prices correspond in magnitude to those of urban prices. Economic theory tells us that the demand for a commodity is not dependent so much on the absolute price but rather the price of that commodity relative to the prices of all other commodities which compete for the consumer's purchases. Accordingly, the price of sugar was deflated by the retail price indices (see Table III-1).

The miscellaneous factors other than prices and income which affect the demand for sugar are difficult to measure. They include improvements in transportation and distribution facilities, changing habits, and increased knowledge. It was assumed that these factors would evidence themselves in a general overall rising trend of sugar consumption apart from changes in price and income. Accordingly, the basic equation used to determine the demand for sugar consumption was

(I) $x = a_1 + a_2 \cdot z_2 + a_3 \cdot z_3 + a_4 \cdot z_4,$

where x is a measure of sugar consumption,

   z_2 is a measure of disposable incomes,

   z_3 is a measure of the retail price of sugar, and

   z_4 is a time variable.

The demand equation was fitted using conventional least squares regression techniques for each country. Ten observations were available in the case of Uganda and Kenya. Only nine observations were available in the case of Tanganyika since the 1963 sugar consumption in Tanganyika, which was abnormally low because of serious disruptions in the distribution system, was excluded.[4]

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4. The new Kilombero factory in Tanganyika unexpectedly found it necessary to shut down in February 1963 due to lack of supplies of ripe cane. The Tanganyika government, caught off guard, attempted to make up the deficit by importation through its co-operative marketing organization, Cosata. There were substantial delays in delivery until June. In the meantime. reserve stocks were depleted and many consumers, especially in southern Tanganyika went without sugar for long periods of time.

The analysis was performed under several different assumptions. Two assumptions on price and income elasticities and on the rate of increase over time were tested, namely

(a) that the price and income elasticities of demand for sugar consumption decrease with increasing levels of sugar consumption, and that the increasing trend in sugar consumption results in a constant absolute increase in per capita consumption over time; and

(b) that the price and income elasticities are constant and the trend factors result in a constant percentage increase in consumption per unit of time.

If the first of these assumptions is used then the regression equation may be written

(II) $\quad y = a_1 + a_2 \cdot \log_e \cdot w_2 + a_3 \cdot \log_e \cdot w_3 + a_4 \cdot w_4,$

where

(III) $\quad y \quad =$ sugar consumption,

$\quad w_2 =$ disposable income,

$\quad w_3 =$ the retail price of sugar, and

$\quad w_4 =$ time.

Under the second assumption the demand equation may be written

(IV) $\quad \log_e y = a_1 + a_2 \log_e w_2 + a_3 \log_e w_3 + a_4 \cdot w_4,$

where the variables w_2, w_3, and w_4, have the same meaning.[5]

Sugar consumption and disposable incomes were measured

(a) on an aggregate or total basis, and

(b) on a per capita basis by dividing the aggregate figures by population estimates for each year.

Aggregate and per capita incomes are both given in Table III-1 while Table II-2 contains aggregate and per capita estimates of sugar consumption. If per capita data are used, this involves

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5. Let $\delta y / \delta w_2, \delta y / \delta w_3$, and $\delta y / \delta w_4$ represent partial derivatives. From equation (II) one obtains the following:

Income elasticity $\qquad = (\delta y / \delta w_2) \cdot (w_2 / y) = a_2 / y$

Price elasticity $\qquad = (-\delta y / \delta w_3) \cdot (w_3 / y) = -a_3 / y$

Rate of increase of sugar consumption per unit of time $\qquad = \delta y / \delta w_4 = a_4$

From equation (IV) one obtains the following:

Income elasticity $\qquad = (\delta y / \delta w_2) \cdot (w_2 / y) = a_2$

Price elasticity $\qquad = (-\delta y / \delta w_3) \cdot (w_3 / y) = -a_3$

Percentage rate of increase of sugar consumption per unit of time $\quad = (\delta y / \delta w_4) \cdot (1/y) = a_4$

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an implicit assumption that population growth in and of itself does not influence *per capita* sugar consumption, i.e., given the change in per capita sugar consumption between any two years caused by per capita income, the retail price, and trend factors, a ten per cent rise in population results in exactly a ten per cent rise in *total* sugar consumption. Whereas if aggregate data are used that same ten per cent increase in population may give rise to less than a ten per cent increase in consumption, depending on the magnitude of the coefficient a_4 of the time variable. The influence of population is included in the time variable.[6] If population tended to increased more rapidly among the poorer segments of the population per capita consumption might fall even after the effects of changes in per capita incomes, prices, and time have been considered.

Two assumptions regarding the deflation of prices and income by the retail price index numbers were considered:

(*a*) incomes were both deflated and non-deflated, and

(*b*) the retail price of sugar was both deflated and non-deflated. An increase in the general price level given constant money incomes and a constant retail price of sugar, will decrease real incomes and decrease the relative price of sugar. One would expect a downward adjustment in consumption due to the real income effect and a rise in consumption due to the price effect. Neglecting to deflate incomes or the retail prices assumes some sort of extreme money illusion, but because of our lack of confidence in the retail price index numbers we felt that better fits might be obtained if price and income data were not deflated. In addition the use of several alternative measures might enable one to reduce the degree of multicolinearity between the independent variables.

All of the above assumptions were tested and this entailed sixteen different regressions for each country. The fit of each regression was determined by the coefficient of determination and the effect of each variable on consumption was tested to determine whether the effect was significantly different from zero.

6. Because of the nature of the population data, the inclusion of a population variable as well as a time variable in the demand equation would be redundant since the population data for all three countries are based on a constant percentage rate of increase determined from the inter-censal rate of increase between the two censuses which were held in each country. Thus there is a perfect linear correlation between the natural logarithm of population and time. The coefficients of the time and population variables would be indeterminate and the matrix of the normal equations would be singular.

B. Regression Results

There seemed to be little difference whether the assumption of constant elasticities was used or the assumption of declining elasticities was used. The significance levels and the coefficients of determination were about the same for all regressions under each of the assumptions. Since the assumption of constant income elasticities and a constant rate of increase over time permit an easy translation of the coefficients of the regression equations into price and income elasticities and the percentage rate of increase over time, we will confine our discussion to the results obtained under this assumption.

Table III-2 contains the regression which gives the best fit (the highest coefficient of determination) for each country when consumption and income are measured on a per capita basis and when they are measured on an aggregate basis. The regressions resulting in the second best fit are given also:

(*a*) if the best fitting regression contains negative price or income elasticities,

(*b*) if the second best fitting regression contains less correlation among the independent variables, or

(*c*) if the second best fitting regression has significant variables which are not significant in the best fitting regression.

All regressions not included in Table III-2 either give substantially the same or poorer results, i.e., poorer fits, more correlation among the independent variables, negative price and income elasticities, fewer significant variables, or some combination of these.

The only independent variable which is clearly significant in the regressions is time. The trend influences seem to be highly significant in most of the regressions while income coefficients are moderately significant in only some of them, and prices are not significant in any. The general lack of significance is in spite of the fact that the price and income elasticities for some of the regressions are quite large and the coefficients determination are very high with the exception of the Uganda regressions where consumption and income are measured on a per capita basis. The price and income coefficients, however, have very large variances due to the small number of degrees of freedom and the presence of correlation among the independent variables. The small number of degrees of freedom is caused by the lack of data. In every case where the income elasticity is above 0.3, there is significant correlation between

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TABLE III-2

Regression Results

Country and Basis of Measurement of Consumption and Income***	Income Variable Deflated	Price Variable Deflated	a_1	Income Elasticity a_2	Price Elasticity $-a_3$	Annual Per Cent Trend Increase $a_4 \times 100$	Coefficient of Determination (R^2)	Significant Correlation between Independent Variables
Uganda Per Capita ..	No	Yes	3.28682	−.20	.08	1.6**	.507	Price and Time .69
	Yes	Yes	3.12782	.00	.08	1.5**	.500	Price and Time .69
								Price and Income .91
Uganda Aggregate ..	No	Yes	10.89885	.80**	.14	2.4	.935	Price and Time .69
								Price and Income .69
								Income and Time .92
	No	No	10.96521	.81**	.14	2.4	.926	Price and Time .66
								Price and Income .69
								Income and Time .92
Kenya Per Capita ..	No	Yes	3.39241	.45	.46	3.7*	.936	Income and Time .84
	Yes	Yes	3.81773	.27	.44	4.5*	.931	None
Kenya Aggregate ..	No	Yes	11.31517	.27	.44	7.8*	.978	Income and Time .97
	Yes	Yes	13.71899	−.12	.52	6.3*	.977	Income and Time .96
Tanganyika Per Capita ..	Yes	No	2.22355	.82**	.18	3.4*	.985	Income and Time .68
Tanganyika Aggregate ..	Yes	No	10.52862	.84**	.17	3.7*	.985	Income and Time .69

* Coefficient significant with a 5 per cent critical region using one-tailed test of significance.

** Coefficient significant with a 15 per cent critical region using one-tailed test of significance.

***Units of measurement as follows: (1) consumption—per capita (lbs.), aggregate ('000 tons), (2) income—per capita (£), aggregate (£), (3) price (cents), and (4) time — (1954 = 0, 1963 = 9).

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income and time. That is, incomes have been rising over time, and it is impossible to separate out statistically the effects of income and time. The income regression coefficients and the time regression coefficients are not efficient estimates of the true coefficients, and if the true time coefficient is large, it may inflate the income coefficient or vice versa because the two variables move together. The price elasticities are quite small except in the case of Kenya where they are above 0.4. This again is probably due to a high degree of correlation between price and time, in this case a negative correlation between price and time. The correlation is barely not significant at the 5 per cent level.

With a 5 per cent critical region, the time variable is always significant for Kenya and Tanganyika and never significant for Uganda. The lack of significance for Uganda is due to a high variance of the time regression coefficient resulting from a poor fit if a per capita basis is used and from a very high degree of correlation among *all* the independent variables if an aggregate basis is used.

C. Interpretation of the Results

It seems that the only independent variable which has much significance in any of the regressions is time. The trend factors are highly significant while the effects of the retail price of sugar and disposable incomes are very weak. The fits obtained by using a regression containing only time as an independent variable are nearly as good as the fits obtained by including all three independent variables in the regression. The addition of price and income variables does not substantially improve the fits. Income and price elasticities are relatively high only when there is a high degree of correlation between these variables and time. Before we conclude, however, that incomes and the retail price of sugar have no significant influence on sugar consumption, let us consider the possible sources of downward bias in the price and income elasticities.

Bias may be caused by serially correlated error terms. In order to test for serial correlation we used the von Neuman ratio[7].

7. The von Neuman ratio is $N \cdot \sum (u_t - u_t - 1)^2/(N-1) \cdot \sum u_t^2$ where u_t is the deviation of the observation at time t from the regression line. The value of the ratio is $2N/(N-1)$ if there is no serial correlation in the residuals. The distribution of the von Neuman ratio depends on the value of N. Tables may be found in B.I. Hart, "Significance Levels for the Ratio of the Mean Square Successive Difference to the Variance," *Annals of Mathematical Statistics*, Vol. 13 (1942), p. 446, and are reprinted in R. Ferber and P.J. Verdoorn, *Research Methods in Economics and Business*, New York, the Macmillan Company, 1962, Appendix, Table A5, p. 556.

The results were negative in all cases. Thus serial correlation cannot be regarded as a serious problem.

A second source of bias may be due to errors in the independent variable. Least squares estimates are not biased only if all errors occur in the dependent variable. Certainly, there are fairly significant errors in the estimates of disposable income, one of the independent variables. This tends to impart a downward bias to the income elasticities. There are no errors in the retail price of sugar except in so far as there are errors in the price index which is used to deflate the price of sugar. However, the deflation of the retail price of sugar does not result in very different price elasticity estimates from those obtained when price is not deflated.

Thirdly, the nature of the retail price index used to deflate disposable incomes and the retail price of sugar may contribute to downward bias in the estimates of income and price elasticity. These index numbers are subject to wide fluctuations due to temporary food shortages in the major towns. There is reason to believe that fluctuations in prices in the rural areas are not nearly so great. If this is so, then per capita incomes and retail prices would be overdeflated when the retail price index is high and underdeflated when the retail price index is low. The fluctuations in deflated incomes and retail prices would be exaggerated. There is no systematic difference in the magnitudes of the income and price elasticities, however, if price and incomes are deflated on the one hand and not deflated on the other. This leads one to suspect that this effect is probably not very important.

The sources of bias do not seem to be very strong. Thus it is probably safe to say that the income and price *in any year* do not significantly affect per capita sugar consumption at least over the range of income, price, and time covered by the data. This conclusion is bolstered by several observations. Most of the sugar consumed in East Africa is used by the ordinary peasant for sweetening habitual cups of tea and other drinks and in home beer making. There is no close substitute for these purposes except jaggery (*gur*) which is produced in relatively small quantities in East Africa. The price elasticity is probably small for this reason. Since the habit of tea drinking and beer drinking seems to be deeply ingrained, one of the last things dropped from the peasant's budget is probably sugar. Since the food consumption habits of most peasants are usually simple and stable in East Africa, it is likely that

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increases in income do not immediately give rise to increases in sugar consumption. A large part of any increase in incomes is likely spent on such things as clothing, radios, cigarettes, bicycles, petrol, etc., relative luxury goods. These observations, it must be emphasized, are only casual and are not supported for the most part by any careful sociological study or long term budget survey.

Although changes in sugar consumption may be relatively unaffected by price and income for any given year, this is not to say that if income rises over a long period that consumption would be the same as if income did not rise over the same period. Per capita (non-deflated) disposable incomes have risen steadily over the period 1954-63 for Kenya and over the period 1954-62 for Tanganyika at respective average annual rates of 2.8 per cent and 2.9 per cent per annum. Per capita sugar consumption has risen at an average annual rate of 4.8 per cent for Kenya and 5.1 per cent for Tanganyika. On the other hand per capita (non-deflated) disposable incomes have changed very little for Uganda over the period 1954-63, and the average annual rate of increase of per capita sugar consumption has only been 1.7 per cent. The difference in rates of increase of consumption for Kenya and Tanganyika may be due to the consistent rises in disposable incomes which are lacking in Uganda. These observations may be reconciled with our earlier conclusions if we hypothesize that:

(*a*) there is a lagged reaction to income changes, i.e., an income change in year, t, has its effects on consumption in years t+1, t+2, t+3, etc., or

(*b*) any initial change in income is viewed as temporary and some basic consumption patterns are not changed until the change in income had been maintained for several years.

The second of these hypotheses seems reasonable in an East African context. Patterns of spending especially on food items tend to be stable, extra incomes initially go on the relative luxury goods mentioned above, but if the higher income patterns are maintained, then habits and life styles regarding food consumption may change. The first of the hypotheses above may be true if higher levels of income are associated with higher investment in transport and distribution facilities. As these improved facilities come into operation, the increased availability to the consumer may stimulate consumption.

Neither of these hypotheses could be tested adequately with the limited data available. We attempted some regressions with

consumption depending on incomes of the previous year, but the fits were extremely poor and some of the price and income elasticities were negative.

D. Time Series and Cross Section Analysis

Our results of the time series analysis for East Africa are not entirely in accord with the results of Viton and Pignalosa in developing countries.[8] They ran country cross-section regressions for low income countries. The estimated price and income elasticities in all cases were greater than unity. There is no reason to expect, however, similar results from cross-sectional analysis of this sort and time series analysis within any particular country. The cultural differences among countries and differences between different stages of development, even at a relatively low level of development, are neglected. Cross section analysis cannot include time as a variable so that the price and income coefficients may reflect any independent influences which would be represented by time in a time series analysis.

Viton and Pignalosa also did both time series and budget cross-sectional analysis for individual countries. Of the countries for which time series analysis was performed,[9] only South Africa is in any way comparable to the countries of East Africa. The estimated price elasticity for South Africa was of the order of 1.2, and estimated income elasticities were about .5. The high price elasticity is very suspect, however, and is probably a result of the high correlation ($-.89$) between the price of sugar variable and trend factors. The price of sugar in South Africa was reduced substantially between 1918 and 1957, the period covered by the regressions. Budget studies for rural India (1951-53), the Ivory Coast (1953/54), Southern Rhodesia (low income groups 1952), and the United Arab Republic reveal income elasticities for sugar expenditure ranging from .27 to .50. These results are similar to our time series estimates. An urban study in India, however, gave an estimated income elasticity of 1.48.

Our analysis which shows that the demand for sugar is relatively inelastic with respect to both price and income in East Africa differs

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8. A. Viton and F. Pignalosa, *Trends and Forces in World Sugar Consumption,* Commodity Bulletin Series, Food and Agricultural Organization of the United Nations, Rome, 1961, pp. 29, 33, and 77.

9. Australia, Belgium, France, Germany, Italy, Netherlands, and the Union of South Africa.

somewhat from our earlier analysis in Chapter II of geographical differences in per capita consumption within East African countries. It was noted there that the percentage differences in per capita sugar consumption seemed to be much greater than the percentage differences in incomes among regions of Uganda. Part of the differences in per capita consumption may be attributed to differences in price. The poorer, outlying areas are also those areas where prices are relatively high because of transport costs. It is unlikely that these price differences explain all the disparity between cross-sectional and time series evidence. The remaining disparity of demand among the regions probably is explained in terms of differences in elasticity of demand among regions. The poor regions, near the subsistence level, may have very high price and income elasticities, while high-income districts such as Mengo and Busoga may have much lower price and income elasticities. If a higher proportion of sugar is consumed in the high-income, low-elasticity areas, than in the low-income, high-elasticity areas, the time series estimates of income and price elasticities will be weighted in favour of the low elasticity areas. In this type of situation, time series estimates are preferable for making projections. Cross sectional analysis by districts will give a misleading suggestion of income elasticity because of major socio-economic differences among regions and because of the many factors represented by time in our time series analysis. In Chapter II we indicated that most of the sugar was consumed by a small and wealthy proportion of the population. Thus our elasticities estimated from time series will reflect the elasticities of the wealthier regions.

Our comparison of time series results and district differentials in income and sugar consumption suggests that the income elasticity of sugar consumption is lower among relatively wealthy peasant farmers. This leads us to speculate that income and price elasticities in developing countries such as those of East Africa may go through three separate stages. The first stage, a high-elasticity stage, probably occurs when incomes are near the subsistence level. At this stage sugar for sweetening drinks and making beer is a relative luxury good, satisfaction of hunger is the primary concern, and cash incomes are extremely low. The second stage occurs whenever subsistence is assured and cash incomes are larger and more reliable. Sugar becomes a staple commodity like matches, salt, and tea with an inelastic demand. This is the stage which is

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relevant for many of the more wealthy peasant farming regions of East Africa. The third stage occurs with increased consumption of bakery products and sweets. These are luxury goods in most low income countries. Increased consumption of these products raises the overall elasticity of sugar consumption. Most of East Africa has not yet reached this stage. There are no indigenous customs of making baked goods and sweets in the home, and as noted in Chapter II, the consumption of sugar in the form of manufactured bakery products, soft drinks and sweets does not account for a very large proportion of total sugar consumption. Furthermore, most of the consumption of such products is probably done by the high-income expatriate population and African elite. This part of the population has probably reached the final stage found in very high-income countries such as the United States where sugar, like nearly every other food item, is not a luxury good, and the elasticity of demand is again low.

E. Projections

A projection based on a regression equation will not necessarily be as unreliable and have the same biases to which the individual elasticity coefficients are subject. A lack of reliability due to multicolinearity, for example, is not nearly so important in making projections since although it might be difficult to separate out the effects of each of two or three variables in an equation, the total effect is estimated more accurately. A projection based on a regression with multicolinearity present will be relatively accurate if the variables are expected to move approximately at the same relative rates in the future as has been the case in the past. If the regression coefficients for price and income are under-estimates because increases and decreases in the estimates of prices and income exceed variations in the actual values of prices and incomes, then that part of the variation in consumption which should be attributed to income and price will actually be attributed partly to the time variable. If the time variable is included in the projection equation, these effects will be included to some extent in the projections.

The projections, however, will be subject to the same biases as the regression coefficients if there are errors in the independent variables. These biases may tend to cancel out among the different coefficients or they may reinforce each other in making projections. For example, if price and income elasticities are both subject to

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downward bias, then if income is expected to rise and price is expected to rise, the biases will tend to cancel each other out. Since the projections below are based on an assumption of rising incomes and a rising retail price of sugar, and since the income and price elasticity estimates are probably biased downward if anything, the projections are probably not subject to any reinforcement of the biases of the individual regression coefficients.

In order to make projections of the total consumption of sugar for Kenya, Uganda, and Tanganyika, we made the following assumptions:

(1) Gross Domestic Product will increase at an annual rate of 6.5 per cent in terms of current prices, or, alternatively at 4.5 per cent.

(2) Population rates of growth per annum will be:

  (*a*) 2.5. per cent in Uganda,

  (*b*) 3.0 per cent in Kenya, and

  (*c*) 2.2. per cent in Tanganyika.[10]

(3) The retail price indices will rise at the rate of 1 per cent per annum in all three East African countries.[11]

(4) Because of gradual increases in excise taxes, the retail price of sugar will rise at the rate of 2 per cent per annum in all three countries.

(5) The sum of export duties, import duties, and direct taxes (x) will rise along with GDP according to the following regression equations:

  (*a*) $x = 17.064 + .804$ GDP for Uganda, and

  (*b*) $x = -6.738 + .924$ GDP for Kenya and Tanganyika,[12] where all taxes and GDP are measured in £ millions.

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10. The rate of population growth assumed in the Kenya six-year development plan (1964-70) is 3.1 per cent, and that assumed in Tanganyika is 2.2 per cent. See Government of Kenya, *op. cit.*, p.129 and The United Republic of Tanganyika and Zanzibar, *op. cit.*, p.8. The rates above also compare with the intercensal rates of population growth of 2.5 per cent in Uganda (1948-59), 3.2 per cent in Kenya (1948-62), and 1.75 per cent in Tanganyika (1948-57) as estimated by J. G. C. Blacker, "Population Growth in East Africa," *Economic and Statistical Review*, No. 8 (September), 1963, pp.vii-xii.

11. A 6.5 per cent rate of growth in Gross Domestic Product with a 1 per cent rate of growth in prices implies roughly a 5.5 per cent rate of growth in real incomes. The Kenya plan (*op. cit.*, p.129) envisions a rate of growth in real output of 5.2 per cent and the Tanganyika plan (*op. cit.*, p.8) a rate of growth of 6.7 per cent.

12. Regression equations were determined for the three East African countries using the data from Table III-1. The rate at which taxes have been growing relative to GDP has been considerably lower in the case of Tanganyika than in the cases of Uganda and Kenya. Since the current Tanganyika plan envisions a much greater effort than that reflected in past rates of growth, it was felt

TABLE III–3

Sugar Consumption, Projection to 1970

Country		Rate of Growth of GDP	Projection Equation	1970 Projected Sugar Consumption ('000 tons)	Percentage Rate of Growth from Projection Equation
Uganda	..	6.5	$X=10.89885+.80z_2-.14z_3+.024z_4$	122.20	7.1
		4.5		110.74	5.6
Kenya	..	6.5	$X=3.39241+.45z_2-.46z_3+.037z_4$	181.17	7.6
		4.5		171.77	6.8
Tanganyika		6.5	$X=10.52862+.84z_2-.17z_3+.037z_4$	112.90	7.6
		4.5		99.41	6.0

incomes probably do cause rises in consumption but the effects seem to be dissipated over a number of years so that they evidence themselves as a rising trend rather than a very clear correlation between incomes in a given year and consumption in that year. Other possible trend factors are (1) gradual improvement in communications and distribution facilities, (2) a change in the habit of using jaggery (*gur*) as a substitute for sugar, and (3) changing income distribution favouring low income households which tend to have higher individual income elasticities.

A major stimulus to high levels of sugar consumption is continuous availability. Where roads are bad or non-existent and where railroads are non-existent, shipments into an area tend to be worthwhile if a full load or near full load can be carried, if items with a high value relative to weight can be carried at the same time, or if weather conditions are favourable. Because of storage difficulties due to bulkiness and perishability neither households nor traders will carry large inventories of these items to meet the continuous demand between shipments, but find it worthwhile to stock rather more easily stored commodities. Furthermore, consumption cannot be easily postponed as is the case with more durable types of consumer items. Besides transport, factors affecting the continuous availability of sugar supplies are the state of development of other sorts of communications and the number and size of distribution channels. Good communications and distribution facilities enable orders to be filled quickly if there are unexpected changes in demand or disruptions in the usual sources of supply. If there are long delays in filling such orders, some consumption will not be postponed and will be lost. Thus improvements in communications and distribution tend to increase the share of income spent on sugar and similar items even though per capita incomes may remain constant.

If the income elasticities of sugar consumption for low income earners are higher than the income elasticities of high income earners, and if the low income earners increase their share of total income, then per capita sugar consumption will rise even in the absence of an increase in per capita incomes. There is some evidence that such a shift in income distribution has been taking place in East Africa during the period analysed. Between 1954 and 1962, African per capita income in Kenya increased by about 24 per cent while non-African per capita income increased by

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something less, about 19 per cent. For the same period in Uganda non-African per capita income decreased by about 23 per cent while African per capita income decreased by only one per cent. African incomes comprise about 51 per cent in Kenya and about 77 per cent in Uganda of total incomes (including subsistence).[13]

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13. See D. Ghai, "Some Aspects of Income Distribution in East Africa," East African Institute of Social Research, Paper EDRP 52, Kampala, 1964, pp. 12 and 14.

countries feels that the fixed price of sugar is too high in that the consumer is being taxed to support high profits for sugar manufacturers, then the other countries must approve of lowering the price. If one of the countries feels that excise taxes should be raised without reducing the price to the producer, then the other countries must agree on a rise in the price to the consumer. If one country would like to encourage investment in the sugar industry by raising the price to the producer without a reduction in excise rates, then again co-operation must be achieved to raise the consumer price. Under circumstances of free trade, the freedom of any one country to vary policy with respect to producer and consumer prices and excise taxes is severely limited.[1]

The second reason for pressure to limit or cut off entirely imports by one country from the other two relates to a desire for a major expansion in all three countries. The Kenya development plan for 1964-70 calls for an expansion in production from about 40,000 tons in 1963 to 170,000 tons by 1970.[2] The projection of consumption in Chapter III (Table III-3) for Kenya is in the range of 170,000 to 180,000 tons in 1970[3]. Thus Kenya should be nearly self-sufficient by 1970. The Tanganyika development plan for 1964-69 envisages a 1970 output of 105,000 tons compared to the 1963 production figure of about 50,000 tons[4]. With projected consumption in the area of 100,000 tons by 1970 (see Table III-3), Tanganyika should also be self-sufficient by then. Current thinking among Uganda sugar manufacturers and Uganda government circles is that production should be around 170,000 tons compared to a consumption estimate of about 110,000 tons (see Table III-3). Furthermore, negotiations are in progress in all three countries for several new sugar plants whose production has not been included in these

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1. There has not been complete co-operation in the past with regard to common consumer prices. *Official* consumer prices are generally lower in Uganda due to the fact that producers bear a portion of the excise tax. *Actual* prices in areas near the borders may, however, be very similar. In any case, there is some evidence that unrecorded trade in sugar does take place in border areas because of the price differentials. This trade would have a tendency to equalize actual prices taking into account transport costs. Larger price differentials than now exist could probably only be enforced with much stronger controls on the movement of sugar across borders.

2. Government of Kenya, *Development Plan 1964-1970*, Nairobi, Government Printer, 1964, p.52.

3. The consumption estimate for 1970 in the Kenya development plan is 171,000 tons. See Government of Kenya, *op. cit.*, p. 52.

4. The United Republic of Tanganyika and Zanzibar, *Tanganyika Five Year Plan for Economic and Social Development, 1st July, 1964—30th June, 1969* Volume I, Dar es Salaam, Government Printer, 1964, p. 26.

estimates either because the plans are too tentative at this stage or because production cannot be expected to reach full capacity until after 1970. The Commonwealth Sugar Agreement quota for East Africa is 10,000 tons. Of this 10,000 tons, only one-half is given the guaranteed Commonwealth Sugar Agreement price which does not differ significantly from the East African internal price. Thus if planned target rates of production are achieved, the bulk of exported sugar will be sold at the world market price unless some bilateral or multilateral agreement can be reached regarding sugar prices, or unless the Commonwealth Sugar Agreement quota is substantially enlarged. Historically, the world market price has been very unstable and usually below the East African internal price. The Kenya and Tanganyika governments have received requests from prospective investors for some form of guarantee of a certain proportion of the local market as a condition for investing in new sugar manufacturing facilities in East Africa. Thus there is a tendency for Kenya and Tanganyika to view their local markets as assets to be doled out to prospective sugar manufacturers to protect them from the vagaries of the world market price fluctuations and to offer them a relatively high fixed price. In order to do this, the Kenya and Tanganyika governments individually would need to restrict imports from any of the other two East African countries as well as from non-East African countries. If Kenya and Tanganyika restricted imports, it is likely that Uganda would retaliate by doing the same.

Even if Tanganyika and Kenya do not produce enough to satisfy their own needs, it is costly for either of them to import from the other two East African countries if the world market price is below the East African internal price. If the world market price is above the East African internal price, then any East African country with a surplus will find it more profitable to export on the world market (provided the rather small Commonwealth Sugar Agreement quota is satisfied) than to export to either of the other two countries. In the past the East African countries have agreed to export to each other even though the world price is higher than the internal price because of the fear that if prices fall on the world market, they might face retaliation in the form of a refusal to import. If any one East African country refused to import from the other at the internal price when the internal price was higher than the world price, then retaliation might take the form of a refusal to export

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by surplus countries when the world price is higher than the internal price. Also in the past Kenya has been willing to accept Uganda sugar even when world prices were low perhaps because of the fear that if they refused then Uganda would cease to buy farm products from Kenya at a price above the world price.

B. The Model

In order to determine the difference in transport costs resulting from a policy of autarchy (no East African inter-country trade) as opposed to rationalization on an East African basis, it was first necessary to determine the total transport costs under the two different situations. We assumed that if each country did not export or import to the other East African countries, the distribution system *within* each country would be rationalized with respect to transport costs, i.e., the total transport costs from points of production to consuming areas within the country and to the nearest point of exit for exports outside of East Africa would be minimized. If rationalization on an East African basis were pursued, then we assumed that transport costs in East Africa as a whole would be minimized between points of production and consuming areas and the nearest point of exit for exports outside of East Africa. Let C_U, C_K, and C_T be the minimum total cost of transport *within* Uganda, Kenya, and Tanganyika, respectively, where no trade among these three countries is permitted, and let C_{EA} be the minimum total cost of transport in all of East Africa where trade among the countries does take place. Then the difference in transport costs between a policy of autarchy and a policy of rationalization on an East African basis is:

$$S = (C_U + C_K + C_T) - C_{EA}$$

Our model assumes that whichever of the two policies is followed, transport costs will be minimized consistent with that policy. The present system of production and distribution, however, is neither one of national autarchy nor one of complete integration in which transport costs are minimized throughout East Africa. Theoretically, under a system of perfect competition a minimization of transport costs would be achieved. The present situation, where distribution in Kenya is controlled by the Ministry of Commerce and Industry and where the distribution in Uganda and Tanganyika is mostly controlled by a small number of firms who have agreements

among themselves as to the extent of each one's market, is hardly one of perfect competition. Furthermore, there is no conscious effort by any central authority to attempt to minimize transport and production costs. The minimization of transport costs is not necessarily an easy task in the absence of perfect competition. It would require an analysis of the supplies at each factory and the demands in each area, and an attempt to minimize the equation of total transport costs using rather sophisticated mathematical techniques. That the minimization of transport cost is not necessarily a straightforward exercise can be illustrated by the following considerations. Suppose there are two factories, A and B. It may pay for factory A to supply point C even though the transport cost from factory B to point C is lower. The reason is that factory B may be able thereby to supply point D at a much lower cost than factory A. If there are many factories and many points of consumption, the problem becomes even more complex. Because of these considerations, the situation in Tanganyika is one where the minimization of transport costs does not necessarily take place. The two major distributing firms have an agreement that each supplies only those points where its transport costs are the lower. An assumption of the minimization of transport costs under either policy, autarchy or East African rationalization, however, is not necessarily a bad one if the divergencies from an optimal pattern of distribution are about the same in either case. The estimate of savings will not be affected substantially.

Our analysis centred on the year 1970. The estimated difference in transport costs between the two policies applied to 1970 is highly dependent on the estimates of production for each of the factories in existence by 1970. Since the prediction of 1970 production rates is highly uncertain, we performed the analysis using two production estimates, one a maximum production estimate for each factory and the other a minimum production estimate for each factory. One further bit of analysis was performed. We assumed that the total production estimates were satisfied and then allowed the production of each factory as a proportion of total production to vary so that total transport costs would be minimized. This allows extra degrees of freedom and results in an even lower total transport cost than when factory production is given. This analysis was performed for East Africa as a whole assuming both maximum and minimum total production estimates. All of the analysis was

performed using linear programming techniques, specifically the transport linear programming model.[5]

The use of a linear programming model involves several implicit assumptions. One is that there is an even flow of sugar supplies throughout the year between all points of demand. Although production schedules in the past have been uneven, a steady flow can be achieved by holding sufficient stocks at each factory. Another assumption is that the product is homogeneous, i.e., there are no differences in quality or differences are insignificant as far as the consumer is concerned. For the export market price will vary with quality. If quality considerations are taken into account savings in transport costs might be somewhat lower. A third implicit assumption is that cost of transporting a ton of sugar is not dependent on the amount shipped. This is not strictly true as special rates are quoted by East African Railways and Harbours for wagon-load shipments. Smaller consignments involve a higher cost per ton. In practice, however, most of the shipments from each of the factories are wagon-load shipments.

C. Application of the Model

The maximum and minimum estimates of production for East Africa for the year 1970 are given in Table IV-1. The maximum estimates differ from the minimum estimates largely because the production levels of four new factories now in the planning stage are extremely uncertain, and there is the possibility that two minor

TABLE IV-1

Estimated Sugar Production and Consumption in East Africa for the Year 1970
('000 tons)

	Estimate of Consumption	Maximum Estimate of Production	Maximum Surplus	Minimum Estimate of Production	Minimum Surplus
Tanganyika	103	165	62	115	12
Kenya	171	205	34	98	−73
Uganda	111	180	69	160	49
TOTAL EAST AFRICA	385	550	165	373	−12

Source: East African Common Services Organization.

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5. A mathematical exposition of the model and of the solution technique is provided in the appendix to this chapter.

producers in Tanganyika will engage in large scale expansions. In addition to be the gross estimates of production in Table IV-1, we obtained maximum and minimum estimates for each of the twelve factories expected to be in operation by 1970 from the East African Common Services Organization and the Tanganyika Ministry of Commerce and Industry.

Estimated consumption for the year 1970 is also given in Table IV-1. These estimates were provided by the East African Common Services Organization and do not differ significantly from the projected consumption for all three East African countries shown in Table III-3 of the previous chapter. The estimates in Table IV-1 are close to the projected consumption under the assumption of a 4.5 per cent rate of growth of GDP (see Chapter III).

The East African Common Services Organization, the East African Railways and Harbours, and the Ministry of Commerce and Industry in Kenya supplied estimates of consumption by locality in all three territories for previous years. The quality of these estimates varied, and some estimates were in terms of administrative areas (some containing more than one major population centre). Using population data and a knowledge of the relative prosperity and economic activity of each population centre, consumption of sugar in an administrative district was allocated to each population centre so that all consumption estimates were in terms of 60 population centres (towns of about 3000 population or more) in East Africa. The estimates of past consumption of each population centre and surrounding areas were converted into percentages of total consumption within the country in which the centre was located. These percentages were applied to the total consumption estimates of each country for 1970 to obtain estimates of tons of sugar consumed for each population centre for 1970.

Next it was necessary to determine the cost of transporting a ton of sugar from each of the nine points of production and from the nearest point of entry (for imports) to each of the 60 distribution centres and to each port of exit (for exports). A special problem arose in this connection. The two producers in Uganda and the two major producers in Tanganyika have negotiated special rates with East African Railways and Harbours. The Kenya producers and the minor producers in Tanganyika must transport their sugar on the railways at higher rates. Furthermore, the Railways and Harbours Administration is considering a change in their rate system

so that rates correspond more closely with costs. One major change which is being considered is a modification of the taper. (The taper refers to a declining average charge per mile as distance increases). The present taper is such that the charge for each additional mile declines with distance. The Railways and Harbours Administration, however, calculates that the actual cost of each additional mile is the same regardless of distance although there is an initial handling and loading cost. If costs and rates are to be more closely correlated, this would require an initial fee for transporting any distance at all and a constant charge for each additional mile travelled. Of course, under such a system, the average charge per mile would still fall with distance.

In view of these considerations, we assumed that by 1970 all East African sugar producers will have negotiated special rates for the rail and road services of the East African Railways and Harbours and that the taper will be modified to reflect the Railways and Harbours estimates of their actual costs. In order to obtain estimates of rates which would approximate the rates under these assumptions, we calculated two regression lines, one for rail rates and one for road rates, with total transport charge per ton as the dependent variable and distance in miles as the independent variable using the special rates quoted in the East African Railways and Harbours tariff book as separate samples[6]. The regression equations provided estimates of road and rail charges with the following properties:

(1) The charge for each additional mile is constant and the average charge per mile falls with distance, and

(2) Assuming a random distribution of traffic over the sample distances, the expected total revenue obtained using the rates estimated from the regression lines is equal to the expected total revenue obtained under the special rates[7].

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6. See East African Railways and Harbours: Railway, Marine, and Road Motor Services, *Tariff Book, No. 3, Part II*, Nairobi, Government Printer (as supplemented through July, 1963).

7. Proof. Let T be the total annual traffic over the sample distance x_i for $i=1$, ..., n with sample rates y_i, for $i=1, ..., n$. Let w_i, a random variable, be the number of tons of traffic over the route with distance x_i. If $E(w)$ is the expected value of w_i, then since the w_i are all similarly distributed $E(w_i)=w$. The expected total transport revenue using the special rates is:

(a) $$R = w \cdot \sum_{i=1}^{n} y_i = n \cdot w \cdot \bar{y} = T \cdot \bar{y}$$

where y is the sample mean of the special rates. If y_i' for $i=1, ..., n$ are the rates

The first property modifies the taper to correspond more closely with costs, and the second property ensures that the expected total revenue on the basis of the estimated rates equals total costs, assuming that the traffic is randomly distributed over all specially rated routes and that the special rates are expected to cover total cost.

Since the number of supply points (factories) and points of demand (population centres) together were quite large (12 and 60, respectively), and since the computations had to be performed by hand, steps were taken to reduce the scope of the problem. Factories which were within thirty miles of each other were combined into one point of supply. The transport costs from the factories which were combined to form an aggregated point of supply were averaged and the average used as the transport cost from the aggregated point of supply to each point of demand. In order to reduce the number of points of demand, we took advantage of the fact that in many instances from each and every point of supply the cost of transport per ton between two different points of demand differed by the same constant amount. This would occur if it were necessary for supplies from every factory to pass through some common geographical location in order to reach two or more different points of demand. If this occurs then all those points of demand may be combined into one common point of demand. As a result of these combinations the number of points of supply was reduced to nine and the number of points of demand was reduced to thirty-eight.

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estimated by the regression equation for the specially rated routes, then expected total revenue using the estimated rates is:—

(b) $R' = w \cdot \sum y_i$

The rate y_i' is calculated from the regression equation

(c) $y_i' = a + b \cdot x_i'$

where the regression coefficient a is determined from the normal equation.

(d) $a = \bar{y} - b \cdot \bar{x}$

where x is the sample mean of the specially rated distances. Substituting (c) and (d) in (b), we obtain

(e) $R' = w \cdot \sum (y - b \cdot x + b \cdot x_i)$
$= T \cdot y - b \cdot T \cdot x + w \cdot b \sum x_i = T \cdot y$

From (b) we see that $R = R'$.Q.E.D.

D. Results and Conclusions

Table IV-2 summarizes the results of the linear programming calculations. The total possible savings in transport costs are about the same whether the minimum or maximum production estimates hold. The source of savings is vastly different, however. If the

TABLE IV-2

Savings In Transport Costs

	Minimum Production Estimates for 1970 Realized	Maximum Production Estimates for 1970 Realized
Savings through optimal transport if production of each factory given	£249,391	£9,107
Additional savings if production of each factory allowed to vary	£58,990	£342,729
Total possible savings in transport costs	£308,381	£351,836
Estimated total transport costs under autarchy	£1,263,360	£1,858,080
Total possible savings as per cent of estimated total transport costs	24	19
Total value of production (valued at the East African producer price of £46 per ton)	£17,296,000	£25,438,000
Total savings as a percentage of the total value of production	2	1

minimum estimates hold, most of the savings occur because of a reorganization of the distribution channels. If the maximum estimates hold, most of the savings occur because of reallocation of production among the firms. Since the maximum production estimates are based on the assumption that the newer ventures will go ahead as planned, this leads one to suspect that the relative rates of expansion should be quite different if the maximum savings in transport costs are to be achieved.

If the minimum production estimates hold for each factory, then the pattern of distribution changes drastically when sugar is distributed on an East African basis as opposed to the distribution pattern under national autarchy. Kenya no longer has to import to supply Nairobi and its environs, Voi, and Mombasa. Instead these centres are supplied by the Kenya factories near Lake Victoria. The western part of Kenya (Kitale, Eldoret, Kisumu, and Nakuru) and the northern part of Tanganyika (Shinyanga, Mwanza, and Musoma) are supplied by Uganda producers who no longer export. Tanganyika sugar from Arusha Chini, rather than going west to Musoma, and Singida and east for export, goes north to Nairobi, Machakos, and Kitui. Ramisi sugar comes south to Tanga rather than north to Mombasa.

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If the maximum estimates hold for each factory, then there is little difference in the pattern of distribution between a situation of national autarchy and complete integration. The pattern in Tanganyika undergoes no change at all. Uganda producers supply western Kenya (Eldoret, Kitale, Kisumu, Nakuru, and Nairobi), and sugar produced near Lake Victoria in Kenya is exported. Uganda still exports but not so much as under national autarchy.

The estimates of total possible savings in Table IV-2 do not take into account differences in production costs. If there is a difference in production costs and production costs plus transportation costs are minimized, then the savings will necessarily be greater. If there is a 10 to 20 per cent difference in production costs between factories, the savings could be anywhere from 5 to 20 times greater. It is very likely, therefore, that if policies can be devised and adopted which encourage production wherever costs are lowest, then very substantial savings even in comparison to the total value of production can be realized.

On the other hand, the total possible savings in transport costs alone are quite a large percentage of the total estimated transport bill in either case in Table IV-2. To give this figure some context, the total possible savings in transport costs in either case represents about 17 per cent of the estimated 1962/63 Uganda government expenditures on roads, about 10 per cent of the estimated 1962/63 Uganda government expenditure on education, and about 10 per cent of the expenditure on law and order.[8]

One must keep in mind that the savings in transport costs are based on a set of revised transport charges and not actual charges as given in the Official Tariff Book. If the present official rates were used, the savings would be somewhat larger. There is reason to believe, however, that the revised rates more accurately reflect the true costs of transport.

Finally, there is the question of who would benefit from savings in transport costs. Since the total possible savings are only a small percentage of the total value of production, the possible difference in price to the consumer would be almost negligible. Most likely, the only way consumers could benefit significantly would be through a rationalization on the basis of production costs and/or a closer relationship between prices and costs. If the East African producer

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8. See Uganda Government, *1962 Statistical Abstract*, Entebbe, Government Printer, p. 68.

price is lowered for example, then retail prices would be more in line with prices in other sugar producing countries, and consumers would benefit from this lower price. Furthermore, the savings in transport costs would still be the same and constitute a large percentage reduction in price to the consumer. If the savings resulted in a higher price to the producer, it would most likely mean a significant increase in profits. Alternatively, the governments could raise the sugar excise duty and rake off the savings as increased government revenue.

Another way in which the governments could convert the savings in transport costs into increased government revenue is through the operation of a sugar marketing board. If marketing and distribution were handled by such an East African board, any savings in transport costs would be reflected in an increased marketing board surplus at given ex-factory and consumer prices.

APPENDIX TO CHAPTER IV

The total cost of transporting sugar within a given area can be written as follows:—

$$(1) \quad C = \sum_{i=1}^{n} \sum_{j=1}^{m} c_{ij} \cdot x_{ij}.$$

The variable x_{ij} represents the number of tons of sugar delivered from the ith point of supply to the jth point of demand. The constant c_{ij} is the transport cost per ton between the points i and j. There are n points of supply in the area and m points of demand. If the number of tons of sugar available at the ith point of supply is given as a_i and the number of tons demanded at the jth point of demand is given as b_j, then the equations

$$(2) \quad \begin{aligned} &\sum_{j=1}^{m} x_{ij} = a_i, \text{ for } i=1, \ldots, n \\ &\sum_{i=1}^{n} x_{ij} = b_j, \text{ for } j=1, \ldots, m. \end{aligned}$$

must hold. The conditions

$$(3) \quad \begin{aligned} &\sum_{i=1}^{n} a_i = \sum_{j=1}^{m} b_j \\ &x_{ij} \geqq 0, \text{ for } i=1, \ldots, n; \quad j=1, \ldots, m \end{aligned}$$

specify that total demand equals total supply and that the amount transported between any two points cannot be negative.

Let C_T, C_K, and C_U be the minimum total transport costs for the countries of Tanganyika, Kenya, and Uganda, respectively, assuming that no one country will import from the other two. Let C_{EA} be the minimum total transport costs for East Africa as a whole where free movement of sugar across all boundaries is permitted. The value of C_K is obtained by letting m and n represent

the number of points of demand and supply, respectively, in Kenya alone, letting c_{ij} equal the transport cost per ton between all points i and j in Kenya, and letting b_j and a_i be the amounts demanded and supplied at points j and i in Kenya. Then the expression (1) is minimized subject to the restrictions in (2) and (3). The values of C_T, C_U, and C_{EA} are determined similarly. Then

$$(4) \quad S_1 = (C_T + C_K + C_U) - C_{EA}$$

is the savings in transport costs which can be obtained by a policy of complete integration (free movement across all borders) as opposed to a policy of national autarchy (no one country imports from the other two), *assuming that the amounts demanded at each point and the amounts supplied at each point are given as b_j and a_i, respectively.* Now let us assume that the amounts demanded b_j and the *total* Supply $S = \sum_{i=1}^{n} a_i$ are given, but that the individual a_i are now allowed to vary. Then

$$(5) \quad C_R = \sum_{j=1}^{m} c_{ij} \cdot b_j$$

is the minimum total transport costs where

$$(6) \quad c_{ij} = \min_i c_{ij}, \text{ for } \quad j = 1, \ldots, m$$

Furthermore

$$(7) \quad S_2 = C_{EA} - C_R$$

is the additional savings in transport costs which can be obtained by a reallocation of amounts supplied among the various points of supply (assuming that the total amount supplied is given) so that each point of demand receives its allotted amount from the point of supply where transport costs are the cheapest. The sum

$$(8) \quad S = S_1 + S_2$$

is the total savings in transport costs which may be obtained both by allowing free movement of sugar across all borders and by allowing a reallocation of production among the various factories which manufacture sugar.

In order to determine S_1 and S_2 for maximum and minimum production estimates, it was necessary to solve eight different transportation problems, the largest having 48 points of demand

and 9 points of supply. Since an electronic computer was not readily available, we decided to solve them by hand. We devised a simple and fast method of computation, making use of the following theorem:—

Theorem.[9] Let (x_{ij}^*) represent a set of values for the variables x_{ij} for $i=1,\ldots,n$ and $j=1,\ldots,m$. The theorem falls into two parts: (*a*) If (x_{ij}^*) satisfies

$$(9) \quad \sum_1 x_{ij}^* = b_j \quad \text{for } j=1,\ldots,m$$

then (x_j^*) is an optimal solution to the transportation problem (minimizes (1) subject to the restrictions in (2) and (3)) if and only if there exists a set of numbers α_i for $i=1,\ldots,n$ such that

$$(10) \quad \begin{aligned} &\text{If } c_{ij} + \alpha_i > \min_i(c_{ij} + \alpha_i), \text{ then } x_{ij} = 0 \\ &\text{If } c_{ij} + \alpha_i = \min_i(c_{ij} + \alpha_i), \text{ then } x_{ij} \geq 0, \text{ and} \end{aligned}$$

$$(11) \quad \sum_j x_{ij}^* = a_i \quad \text{for } i=1,\ldots,n$$

are satisfied.

(*b*) If (x_{ij}^*) satisfies (11) then (x_{ij}^*) is an optimal solution to the transportation problem if and only if there exists a set of numbers β_j for $j=1,\ldots,m$ such that

$$\text{If} -c_{ij} + \beta_j < \max_j(-c_{ij} + \beta_j), \text{ then } x_{ij}^* = 0$$

$$(12) \quad \text{If} -c_{ij} + \beta_j = \max_j(-c_{ij} + \beta_j), \text{ then } x_{ij}^* \geq 0$$

and (9) are satisfied.

The above theorem states that if it is possible to find a set of numbers α_j and a solution (x_{ij}^*) which satisfy (9), (10), and (11), then (x_{ij}^*) is an optimal solution to the transportation problem. Furthermore, if (x_{ij}^*) is an optimal solution to the transportation problem, then

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9. The proof of this theorem may be found in H. Kuhn, "Methods of Solving Transportation Problems," Princeton, New Jersey, Princeton University, (unpublished). See also M. Gerstenhaber, "A Solution Method for the Transportation Problem," *Journal of the Society for Industrial and Applied Mathematics*, December, 1958, pp. 321-334.

there exists a set of numbers α_i such that (9), (10), and (11) are satisfied. Our algorithm consists of finding successive approximations to the numbers α_i and solutions (x_{ij}) which satisfy (9) and (10) but not necessarily (11). When a solution is reached (11) is satisfied as well.

The algorithm may be described as follows:

(a) Let (x_{ij}^t) be the solution at stage t in the algorithm, and let α_i^t be the values of the α_i for $i=1,\ldots,n$ at stage t. Initially, let the α_i^o be arbitrary for $i=1,\ldots,n$. Let $\min_i(c_{ij} + \alpha_i^o) = c_{Ij}+\alpha_I^o=\beta_j^o$. Then set

$$x_{ij}^0 = \begin{cases} b_j, & \text{if } i=I \\ 0, & \text{otherwise} \end{cases} \quad \text{for } j=1,\ldots,m.$$

(b)   Define the following quantities:

$$\beta_j^t = \min_i \ (c_{ij} + \alpha_i^t) \text{ for } j=1,\ldots,m,$$

$$E_i^t = \sum_{j=1}^m x_{ij}^t - a_i \quad \text{for } i=1,\ldots,n, \text{ and}$$

$$E_{I'}^t = \begin{cases} \max_i E_i^t, & \text{if } \max_i E_i^t \geqq \max_i (-E_i^t) \\ -\max_i (-E_i^t), & \text{if } \max_i E_i^t < \max_i (-E_i^t) \end{cases}$$

Then follow either step below, whichever is appropriate.

(b.1) If $E_{I'}^t < 0$, define the set $\gamma(I')$ as follows:

$$\gamma(I') = \left\{ j \mid x_{ij}^t > 0 \text{ for at least one } i \neq I' \right\} \cdot \text{Set}$$

$$\triangle = \min_{j \varepsilon \gamma(I')} (c_{I'j} + \alpha_{I'}^t - \beta_j^t)$$

$$= c_{I'J} + \alpha_{I'}^t - \min_i (c_{ij} + \alpha_i^t)$$

$$= c_{I'J} + \alpha_{I'}^t - c_{I''J}'' - \alpha_{I''}^t)$$

(b.2) If $E_{I'}^t > 0$, define the set $\gamma(I')$ as follows:

$$\gamma(I') = \left\{ j \mid x_{I'j} > 0 \right\} \cdot \text{Set}$$

$$\triangle = \min_{\substack{i \neq I' \\ j \varepsilon \gamma(I')}} (c_{ij} + \alpha_i^t - \beta_j^t)$$

$$= \min_{\substack{i \neq I' \\ j \varepsilon \gamma(I')}} (c_{ij} + \alpha_i^t - c_{I'j}' - \alpha_{I'}^t)$$

$$= c_{I''J}'' + \alpha_{I''}^t - c_{I'J}' - \alpha_{I'}^t$$

(c) In order to determine the α_i and the x_{ij} at stage $t+1$, set

$$\alpha_{I'}^{t+1} = \begin{cases} \alpha_{I'}^t + \triangle, & \text{if } E_{I'}^t > 0 \\ \alpha_{I'}^t - \triangle, & \text{if } E_{I'}^t < 0 \end{cases}$$

$$\alpha_{I'}^{t+1} = \alpha_i^t \quad \text{for } i \neq I', \text{ and set}$$

$$x_{ij}^{t+1} = x_{ij}^t \quad \text{for } j \neq J$$

For $j=J$, use one of the following four rules, whichever is applicable:

(c.1) If $E_{I'}^t > 0$ and if $x_{I'J}^t \leq E_{I''}^t$, let

$$x_{iJ}^{t+1} = \begin{cases} x_{i'J'}^t, & \text{if } i = I'' \\ 0, & \text{if } i = I' \\ x_{iJ'}^t & \text{otherwise} \end{cases}$$

(c.2) If $E_{I'}^t > 0$ and if $x_{I'J}^t > E_{I'}^t$, let

$$
x_{iJ}^{t+1} = \begin{cases} x_{I'J} - E_{I'}^t, & \text{if } i=I' \\[2mm] E_{I'}^t, & \text{if } i=I'' \\[2mm] x_{iJ}^t, & \text{otherwise} \end{cases}
$$

(c.3) If $E_{I'}^t < 0$ and if $x_{I''J}^t \leqq E_{I''}^t$, let

$$
x_{iJ}^{t+1} = \begin{cases} x_{I''J}^t, & \text{if } i=I' \\[2mm] 0, & \text{if } i=I'' \\[2mm] x_{iJ}^t, & \text{otherwise} \end{cases}
$$

(c.4) If $E_{I'}^t < 0$ and if $x_{I''J}^t > E_{I'}^t$, let

$$
x_{iJ}^{t+1} = \begin{cases} E_{I'}^t, & \text{if } i=I' \\[2mm] x_{I''J}^t - E_{I'}^t, & \text{if } i=I'' \\[2mm] x_{iJ}^t, & \text{otherwise} \end{cases}
$$

(*d*) Whenever $E_i^t=0$ for all $i=1,\ldots,n$, an optimal solution to the transportation problem has been reached.

The above algorithm has an explanation in economic terms. In step (*a*), the numbers α_i^o for $i=1,\ldots,n$ are the initial prices per ton of sugar asked by each supplier at each point of supply. Buyers at each point of demand ask for the full amount demanded b_j from one of the suppliers, say from point I, for which the supply price α_i^o plus transport cost c_{ij} is the lowest. The result is that the total amount demanded from some suppliers $\sum_j x_{ij}^o$ may be greater than the total amount which he can supply a_i. For other suppliers the opposite situation may hold. That is, for some suppliers there may be an excess demand $(E_i^o>0)$ and for others an excess supply $(E_i^o<0)$.

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In order that the system approach equilibrium, the asking prices must be altered. We assume that the supplier at point I' who has one of the largest excess demands or excess supplies is the first to modify his asking price α_i. If the supplier at point $1'$ who has an excess demand ($E_j^t > 0$), he raises his asking price by an amount $\triangle$ sufficient to cause buyers from at least one point of demand to ask for sugar from a supplier at some point other than I'. In order to determine $\triangle$, one looks at all points of demand from which buyers ask for sugar from the point I', this is the set $\gamma(1')$. For each of these points of demand, we determine the minimum rise in price which will cause buyers from that point to go elsewhere because the asking price plus transport cost is lower. Then we set $\triangle$ equal to the least of these minimum rises in price. When the asking price at point I' is raised by $\triangle$, buyers from the point of demand J begin to ask for sugar from point $1''$, instead of I', thus reducing the excess demand at I'. Now if the supplier at point I' has an excess supply, he lowers his asking price by an amount $\triangle$. In this case one determines $\triangle$ by first looking at all points of demand from which buyers are asking for sugar from points other than I'; this is the set $\gamma(I')$ for the case where $E_{I'} < 0$. Then for each of these points of demand, we determine the reduction in asking price necessary to cause buyers to switch to the point of supply I'. The asking price is lowered by $\triangle$, the minimum of these reductions in asking price. Then buyers from the point of demand J switch from the point of supply I'' to the point of supply I', thus reducing the excess supply at I'. At all times during the process, buyers at each point of demand ask for sugar from the point of supply for which the asking price α_i plus transport cost c_{ij} is the lowest. That is, the conditions set by (10) are always satisfied. When $E_i^t = 0$ for all points of supply, an equilibrium has been reached since there are no excess demands and no excess supplies. At this point total transport cost (1) is minimized and the conditions (2) and (3) are satisfied. The four rules (c.1) through (c.4) insure that no point of supply switches from an excess demand to an excess supply or from an excess supply to an excess demand at any one stage in the process. This helps prevent cycling although cycling is not eliminated and may occur whenever $\triangle = 0$, i.e., whenever a supplier may get rid of a surplus or make up a deficit through no reduction in the asking price. In performing the algorithm by hand, however, it is relatively easy to choose the proper point of supply in order to break the cycle.

In performing the algorithm above it is simplest to work at all times with the matrix whose entries are $c_{ij} + \alpha_i^t + \beta_j$ for $i=1, \ldots, n$ and $j=1, \ldots, m$. Since the conditions in (10) are always satisfied, according to the definition of β_j^t, we have

(13) $c_{ij} + \alpha_i^t - \beta_j \geq 0$ for all i and j, and

if $c_{ij} + \alpha_i^t - \beta_j^t > 0$, then $x_{ij}^t = 0$.

One may infer from (13) that the final α_i^t and α_j^t are nothing more than the shadow prices or the optimal solution to the dual transportation problem. Only if the asking price, α_j or the price at the source of supply, plus transport cost is equal to the demand price, β_j or price at the source of demand, is sugar transported from point i to point j. If the price at the source of supply i plus transport cost is greater than the price at the source of demand j, then no sugar is transported from point i to point j, i.e., $x_{ij}=0$. The condition (13) also implies that the final x_{ij} do indeed minimize transport cost. Thus the algorithm provides a solution to the primal problem and the dual problem simultaneously.

The computations were further simplified by setting any of the entries in the matrix which were larger than their row minimums by some specified amount equal to an arbitrarily large number M and neglecting these entries in the matrix during the computational procedure. At the end of the procedure, the final α_i were added to the the original entries in the transportation cost matrix and a new solution (x_{ij}) determined. If this solution satisfied (9), (10), and (11), it was an optimal solution. Otherwise the final α_i were used as the initial α_i for a new round of computations.

There was one final shortcut. In order to facilitate solving the East African transportation problem (with a 48 by 9 transport cost matrix), we used the final asking prices α_i of the smaller transportation problems involving Kenya, Uganda, and Tanganyika as initial asking prices for the larger problem.

Using the above algorithm and its modifications, we were able to solve the large 48 by 9 transportation problems in a few hours each. The algorithm is very efficient for computation by hand as it is readily amenable to *ad hoc* changes in the rules which on heuristic grounds would seem to lead to a faster solution.

One may derive an algorithm similar to the one above by operating on bid prices. That is, buyers at each point of demand set an initial bid price of β_j^0 and each supplier offers his whole amount supplied α_i to the point of demand where the bid price less transport cost is the highest. Those points of demand which are oversupplied lower their bid prices and those points which are undersupplied raise their bid prices. A solution results whenever bid prices are such that no point of demand has an excess supply or an excess demand. This algorithm takes advantage of part (b) of the Theorem above. During the whole computational procedure conditions (14) and (18) are satisfied and when the optimal solution is reached, equation (9) is satisfied.

Either of the algorithms which we may devise, the one operating on asking prices and the other operating on bid prices, may be viewed as a market mechanism in which, if equilibrium is reached, transport costs are automatically minimized. In the one case, the amounts demanded from each point of supply adjust through variations in the asking price. In the other case, the amounts supplied to each point of demand adjust with variations in the bid price.

CHAPTER V

THE FUTURE EXPANSION OF THE SUGAR INDUSTRY

Two questions are relevant in considering the future expansion of the sugar industry in East Africa. First, should the industry be encouraged to expand? The answer to this question will depend on the relationship between social costs and social benefits. *Social benefits* may be considered roughly as the total addition to national product, including the product of those projects which are complementary or induced by investment in sugar and including the increase or decrease in product resulting from external economics or diseconomics. In theory the increased product must be valued at prices which are not distorted by various sorts of market imperfections. *Social costs* are the opportunity costs in terms of forgone increases in social benefits resulting from employment of inputs in sugar production rather than alternative activities.

Secondly, is the question of whether the industry will expand quite apart from the question of whether it ought to expand. The answer to this question relies on the relationship between private costs and private benefits. *Private costs* are the actual financial costs to the producer and *private benefits* are actual financial revenues which may result from monopoly prices or prices distorted by other market imperfections.

If it is decided that the relationship between social costs and social benefits warrants future growth of the industry while the relationship between private costs and benefits is such that expansion might not take place among private producers, then the government might well consider taking the necessary steps through taxation policy, incomes policy, price policy for controlled prices, or through direct aid or subsidy to alter the relationship between private costs and private benefits. Alternatively, the government may want to undertake the investment by itself directly or offer generous financing to private producers. This chapter is an attempt to assess the relationship between real or social costs and benefits while the following chapter will consider ways in which government policy might affect the relationship between private costs and benefits and bring them into line with social costs and benefits if necessary.

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A. The Unit of Production

The production of sugar cane and the manufacture of sugar from sugar cane are often highly integrated operations. The sugar factory is usually located in the middle of the sugar cane growing area. This close proximity is required since sugar cane is highly perishable and must be processed within twenty four hours or so or inversion will convert the sucrose into an uncrystallizable form. The location of the factory in the midst of the cane growing area is also desirable since in order to operate efficiently, the factory must have constant supplies of high quality cane. The factory managers are able to exercise constant supervision to ensure continual harvesting and transport of cane to the factory and to keep a close watch on quality. In view of the highly integrated nature of the cane and sugar producing operations, we shall consider them together as a single process.

B. The Cost of Sugar Production in East Africa

It is extremely difficult to assess the cost of production of sugar in East Africa because of the lack of published data. Little information is available in the form of balance sheets or accounting data because many of the East African producers have not formed public companies. Thus annual reports are not generally distributed. Some information was obtained through a questionnaire but is of limited usefulness because of the low response rate and because of the confidential nature of the information. A cost investigation into the sugar industry is being sponsored by the East African governments, but the results will be some time in coming. Despite these difficulties, it is possible to arrive at some tentative and qualitative conclusions concerning both the real and private costs of producing sugar in East Africa.

The important consideration in assessing the desirability of sugar expansion in East Africa is the return from sugar relative to the returns from other uses of capital in East Africa. Some useful conclusions may be derived, however, by a comparison of the cost of production elsewhere. If costs compare favourably with elsewhere, there may be a *prima facie* case that relative returns in East Africa indicate that further expansion is desirable. Factors contributing to low real costs in East Africa relative to many other countries are high yields per acre, a long harvesting season, and a low opportunity cost or social cost of land and labour. Factors tending to

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make costs relatively high are low labour productivity and the high opportunity costs of capital; imported machinery and equipment, imported fuels, fertilizers and chemicals; and skilled labour and managerial personnel.

C. Yields

Tonnage yields of sugar or sugar cane per acre are not only an indication of the returns to land but they may also be an indication of the returns to capital and labour. This is true for several reasons. First of all, one of the major capital expenses in establishing a sugar enterprise is that involved in clearing and grading the land and providing for proper drainage. Another large capital expense which may be involved is the provision of irrigation facilities, pumps, pipes, irrigation ditches, etc. The less area cleared and irrigated per ton of annual sugar output, the smaller are these capital expenses. Higher yields per annum also reduce the area ploughed, cultivated and weeded per ton of sugar output.

Another significant expense in sugar production is the cost of transport from the field to the factory. The smaller the area needed for a given output of cane, the less expense involved in transport and the quicker the cane can be brought to the factory, reducing the loss of sucrose content due to inversion[1].

Yields of sugar per acre are stated in several different ways. Yields may be stated in terms of sugar cane per acre or in terms of actual sugar per acre. The yield of sugar per acre depends on the yield of sugar cane per acre, on the sucrose content of the cane, and on the efficiency of the mill in extracting the juice from the cane and the sucrose from the juice. The biggest single factor affecting sugar yields per acre in different countries, however, is the different cane yields per acre[2]. The sucrose content and extraction rate do not seem to explain much of the variation in yields between countries as may be seen by inspection of Table V-1. The countries have been ranked according to average cane yields over the period

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1. Sugar manufacturers often quote 10 miles as the maximum distance over which cane may be transported to the factory. In fact, however, one manufacturer in Kenya obtains some of his cane from about 30 miles away. Other producers also crush cane transported over 10 miles.
2. V. P. Timoshenko and B.C. Swerling state that "high sugar yields per acre are associated much more closely with high crop tonnage than with high extraction rates." See *The World's Sugar*, Stanford, California, Stanford University Press, 1957, p.43.

TABLE V-1

Sugar Yields in Major Cane Producing Countries
(long tons per acre harvested)

Rank According to Sugar Cane Yield	Country	Rank According to Sugar Yield	Average yield 1955/56—1959/60	
			Sugar Cane	Sugar
1	Hawaii	1	82.8	9.1
2	Peru	2	66.0	7.2
3	United Arab Republic	3	41.0	4.4
4	British Guiana	7½	38.8	3.6
5	Florida (USA)	7½	35.2	3.6
6	Barbados	5½	33.6	3.7
7	Taiwan	4	31.4	3.9
8	Indonesia	9	31.2	3.5
9	South Africa	10	30.6	3.4
10	Trinidad*	13½	28.6	2.8
11	Australia	5½	26.7	3.7
12	Puerto Rico	13½	25.4	2.8
13	Mauritius	11	24.9	3.1
14	Jamaica	16	23.3	2.4
15	Fiji	12	23.1	3.0
16	Mexico	17	22.6	2.2
17	Reunion	15	22.3	2.6
18	Louisiana (USA)	19	20.6	1.8
19=	Cuba	18	16.6	2.1
19=	Brazil	20	16.6	1.5
21	Argentina	22	13.8	1.1
22	India	21	13.5	1.4

Source: *The World Sugar Economy: Structure and Policies*, London, The International Sugar Council, 1963, Vol.I, *passim*.
  * Yields refer to estate grown cane only.

1955/56 to 1959/60 and according to sugar yields over the same period. There is little difference in these rankings except for Australia.[3] Australia is reputed to have the world's highest sugar extraction rates, and thus has a relatively high sugar yield per acre although cane yields are only average.[4]

Much of the variation in yields of sugar cane per acre is due to two factors: (1) the length of the growing season, and (2) the use of irrigation techniques. Hawaii, in particular, has an extremely long growing season, ranging from 22 to 24 months. This accounts partly for the high cane yields in Hawaii. Louisiana, which has one of the lowest cane yields per acre, has a very short growing season, about 10 months (see Table V-2). Yields of cane and sugar

3. The Spearman rank correlation coefficient is .942 which is significant with a one per cent critical region.
4. See *The World Sugar Economy: Structure and Policies, op. cit.*, Vol. 2, p. 69.

have been adjusted in Table V-3 to take into account the length of the growing season. Yields in this table are yields per annum which are obtained by dividing the raw yields in Table V-1 by the length of the growing season in months and multiplying by twelve. The estimated growing seasons for the purpose of these calculations are given in Table V-2. The result of the adjustment for length of

TABLE V-2

Growing Season and Land Organization in Major Cane Producing Countries

Country	Estimated Average Growing Season (*months*)	Land Organization
1. Hawaii	23	predominantly plantation: irrigation.
2. Peru	17	mostly large estates: irrigation.
3. United Arab Republic	20	———
4. British Guiana	13	large estates: some co-operatives.
5. Florida (USA)	14	very large plantations: irrigation.
6. Barbados	13	80 per cent mill owned estates: 20 per cent peasant farms.
7. Taiwan	18	one third mill owned estates: balance is peasant production.
8. Indonesia	18	75 per cent large estates: 25 per cent peasant production.
9. South Africa	18	25 per cent factory estates: 75 per cent small and medium sized farms.
10. Trinidad	13	50 per cent estate production: yields given only for estate cane.
11. Australia	13	mostly small to medium sized independen farms: co-operative harvesting.
12. Puerto Rico	14	mostly peasant production.
13. Mauritius	13	50 per cent mill estates.
14. Jamaica	13	55 per cent mill estates.
15. Fiji	14	mostly small farms: co-operative harvesting.
16. Mexico	13	small growers organized into large co-operatives.
17. Reunion	14	46 per cent large estates.
18. Louisiana (USA)	10	medium sized holdings.
19. Cuba	13	as of 1961 35 per cent co-operatives and 65 per cent state and individual farms.
20. Brazil	13	no more than 50 per cent mill estate cane (by law).
21. Argentina	10	one third estate grown cane.
22. India	13	mostly small holdings: larger scale irrigated farms in South.

Sources: Average growing season estimated from information in *The World Sugar Economy: Structure and Policies*, Vol. 2, London, The International Sugar Council, 1963, pp. 65-69 and in V.P Timoshenko and B.C. Swerling, *The World's Sugar*, Stanford, California, Stanford University Press, 1957, p.45. Information on land organization from *The World Sugar Economy: Structure and Policies*, Vol. 2, *passim*.

growing season is that the United Arab Republic, Taiwan, Indonesia, and South Africa drop significantly in the rankings because of the long growing seasons in these countries. Trinidad, Mauritius, Australia, and especially Louisiana rise considerably in the rankings as a result of short growing seasons.

Hawaii and Peru maintain their high rankings in spite of their exceptionally long growing seasons. The high yields in Hawaii and Peru, however, are due in large part to the fact that nearly all the acreage in these two countries is under irrigation. Yields in India vary considerably. Although India ranks very low in terms of average yields, irrigation results in much higher yields. In Bombay and Madras, 35 to 40 tons are obtained per acre[5]. Irrigation is used very little elsewhere. It has been estimated that not more than 10 per cent of the world's cane acreage is under irrigation[6]. Experience in East Africa has indicated that yields may be increased up to 100 per cent through the proper use of irrigation.

TABLE V-3
Sugar Yields in Major Cane Producing Countries
Adjusted for Length of Growing Season
(long tons per acre per annum)

Rank by Sugar Cane Yield	Country	Rank by Sugar Yield	Average yield 1955/56—1959/60	
			Sugar Cane	Sugar
1	Peru	1	46.6	5.1
2	Hawaii	2	43.2	4.8
3	British Guiana	5	35.8	3.3
4	Barbados	3½	31.0	3.4
5	Florida	6	30.2	3.1
6	Trinidad	9½	26.4	2.6
7	Lousiana	16	24.7	2.2
8½	United Arab Republic	9½	24.6	2.6
8½	Australia	3½	24.6	3.4
10	Mauritius	7	23.0	2.9
11	Puerto Rico	12	21.8	2.4
12	Jamaica	16	21.5	2.2
13	Taiwan	9½	20.9	2.6
14½	Indonesia	13½	20.8	2.3
14½	Mexico	13	20.8	2.0
16	South Africa	13½	20.4	2.3
17	Fiji	9½	19.8	2.6
18	Reunion	16	24.7	2.2
19	Argentina	21½	16.6	1.3
20½	Cuba	19	15.3	1.9
20½	Brazil	20	15.3	1.4
22	India	21½	12.5	1.3

5. V.P. Timoshenko and B.C. Swerling, *op. cit.*, p. 47.
6. *Ibid.*, p. 48.

Another important factor causing variations in yield is the production techniques and crop husbandry practices. In general cane grown on plantations involves more capital intensive techniques and better agricultural practices, e.g. optimum use of fertilizers, compared to the cane grown on peasant farms. From Tables V-1, V-2, and V-3 one may observe that higher yields are usually associated with a larger percentage of cane grown on plantations. Australia and South Africa are a bit exceptional in this respect as they obtain average yields with non-plantation production, but it seems reasonable that their small and medium sized farms are run with a higher degree of capital intensity and better agricultural practices than would be found on peasant farms.

Yields may also vary somewhat according to planting practices. Cane grown directly from setts results in higher yields and a longer growing season than the yields and growing season of ratoon crop cane. Ratoon crops are obtained by letting the cane grow up again after harvesting without re-ploughing the area. Practices regarding ratoon crops vary considerably from country. Ratooning is particularly prevalent in Cuba where standard practice calls for seven cuttings or more and is non-existent in heavily populated Indonesia and Taiwan where the scarcity of land makes it desirable to obtain maximum yields even though ratooning permits savings on capital and labour inputs. In most other countries, one to five ratoon crops are usual[7].

Finally, variations in yields may be due to differences in climatic and soil conditions, the incidence of diseases and pests, and the type or variety of cane which is planted. Sugar cane requires a hot and moist climate. Active growing only takes place when temperatures are above 20°C. and rainfall is at least 45 or 50 inches per annum. Since cane has one of the highest water requirements of any commercial crop, soils must have considerable water retaining power. On the other hand, soils must be able to remove excess water so that a clay standing on a porous sub-stratum is highly desirable. Although rainfall must be plentiful, cane cannot fully ripen unless there is a dry period[8]. Much of the difference in cane yields can be attributed to these natural factors and to the variety of cane which is grown.

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7. V.P. Timoshenko and B.C. Swerling, *op. cit.*, p. 45.

8. *The World Sugar Economy: Structure and Policies*, Vol. 1, *op. cit.*, p. 61.

Yields in East Africa vary considerably as cane is grown under a variety of climatic conditions: on large estates, small estates, and peasant farms; and with and without irrigation. Some of the best cane growing land in East Africa is found in Uganda around Lake Victoria. Estate grown cane in this area yielded about 63 tons per acre on irrigated plots and 45 tons per acre on unirrigated land in 1963. The average growing season is about 18 months so that the yield per acre per annum is 42 tons for irrigated cane and 30 tons for non-irrigated cane. The irrigated cane yields are of the same order as those obtained in Peru and Hawaii and the unirrigated cane yields are equivalent to the best average yields obtained elsewhere (see Tables V-1 and V-3). As at least 80 per cent of the cane grown and processed in Uganda is estate grown cane in the Lake Victoria region, the 1963 average cane yields for Uganda probably rank among the highest in the world.

Most of the cane grown in Tanganyika is grown on two large irrigated estates. One of these estates has not reached full operation, but the other which has been operating for several decades, has managed to obtain yields which are truly spectacular. The 1963 yield per acre of irrigated cane on this estate was about 85 tons. With an average growing season of 20 months, the acreage yield per annum works out to 51 tons which is higher than the average yield of *any* country for the period 1955/56—1959/60. The amount of water available for irrigation on this estate is very limited so that every effort has been made to increase yields. Admittedly, this fact has probably meant that cane growing on this plantation may be more capital or labour intensive than otherwise, but it still indicates that very high yields are possible in parts of East Africa.

Yields in Kenya are not nearly so impressive, but are not untypical of those obtained in most sugar growing countries. Yields for estate grown unirrigated cane in the western part of Kenya near Lake Victoria are about 30 to 35 tons per acre with a 21 month growing period or about 19 tons per annum. Yields for cane grown near the coast of Kenya run no more than about 15 tons per annum without irrigation. Yields on the small estates in Tanganyika are also quite modest, running about 15 tons per acre per annum.

One may conclude that sugar expansion in East Africa may be undertaken with very high yields provided the area to be expanded is chosen properly and/or good estate management is provided. As some of the expansion in East Africa will be based on cane

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provided by peasant outgrowers, future average yields may not be so impressive. Relatively good yields may be maintained, however, if good supervision by estate personnel or agricultural extension can be provided although the cost of such supervision must be evaluated carefully. In any case, even a differential between estate and peasant grown cane yields in the range of 50 per cent of estate yields would mean peasant yields in East Africa about average compared to other peasant cane growing countries.

D. Harvesting Season

Sugar cane is harvested practically the year round in East Africa. Thus the factories can be kept in continual operation except for a month or so when the mill requires repairs and maintenance anyway. This permits an economical use of capital and labour employed in the plant and in the harvesting operations compared to many other cane producing areas where only intermittent use is possible. In Argentina, Queensland, and Lousiana, the cane must be harvested before the frost sets in and the grinding season lasts only a few months. A five month harvesting season is prevalent in the Carribean while harvesting in South Africa lasts about nine months. Peru, Hawaii, and parts of India tend to draw out the harvesting all year round.[9]

E. Land Costs

The opportunity cost of land in East Africa is generally considered to be low both because of low population density (in some areas) and because of the low productivity of the peasant farmers and pastoralists who occupy most of the land. The low population density of East Africa (about 37 persons per square mile) is very misleading, however, as an index of land costs for increased sugar production. In Uganda, the districts which are considered to be the most likely candidates have relatively high population densities: Bugisu, Bukedi, Busoga, Mengo, Masaka, Toro, and Bunyoro have densities of 329, 254, 197, 138, 117, 74, and 27 persons per square mile. A good part of Toro is mountainous and much of Bunyoro is swampy. The possible sugar growing areas in these districts certainly have higher population densities. In Kenya the two main sugar growing provinces, Nyanza Province and Coast Province have

9. V.P. Timoshenko and B.C. Swerling, *Op. cit.*, pp. 46-47.

population densities of 272 and 28 persons per square mile, respect-
ively.[10] Only a small part of the more densely populated land very
close to the shore area in the Coast Province is suitable for cane
growing, however.

The pressure on the land in some of the more heavily populated
districts is considerable. Even though peasant productivity in these
areas is low, the use of such land for sugar expansion would involve
substantial compensation and/or relocation costs. In Uganda and
Kenya, in particular, some of the present cane growing projects
are in the midst of heavily populated areas and the land costs
involved in the expansion of these present projects might be
considerable.

Another factor which must be taken into account in assessing
the opportunity cost of land is the quality of the land and its location
relative to sources of raw materials and markets. Much of the
sparsely settled land in East Africa is either arid or far from markets
or both. This is true, for example of the Rufiji basin area of Tanga-

TABLE V-4
1962 Population Density of Selected Less-Developed, Sugar Growing Areas
(persons per square mile)

Barbados	1380	Masaka	117*
Mauritius	934	Toro	74*
Taiwan	806	U.A.R.	69
Puerto Rico	707	Fiji	59
Trinidad	445	Mexico	49
Jamaica	384	East Africa	37
India	379	South Africa	36
Reunion	364	Coast	28
Bugisu	329*	Bunyoro	27*
Nyanza	272	Brazil	23
Bukedi	254*	Peru	23
Busoga	197*	Argentina	20
Indonesia	169	British Guiana	8
Cuba	159		
Mengo	138*		

* 1959 population density.

Sources: United Nations, *Demographic Yearbook 1963*, New York, 1964,
Table I, pp. 123-141.
Uganda Government, *Statistical Abstract 1963*, Entebbe, Govern-
ment Printer, 1963, Table UB4, p. 7.
Government of Kenya, *Statistical Abstract 1964*, Nairobi,
Government Printer, 1964, Table 12, p. 8.

10. Population data for Uganda refer to the 1959 census and may be found
in Uganda Government, *Statistical Abstract 1963*, Entebbe, Government Printer,
1963, Table UB4, p.7. For Kenya, population data refer to 1962 census and may
be found in Government of Kenya, *Statistical Abstract 1964*, Nairobi, Govern-
ment Printer, 1964, Table 12, p.8.

nyika, which is generally regarded as a high potential area for sugar production. The opportunity cost of well watered, fertile land near markets may be comparatively high.

Certainly the opportunity cost of land in East Africa is lower than that in most developed countries. Comparing population densities in East Africa with the population densities in other less developed sugar growing areas (see Table V-4), one notes that the district densities in East Africa compare very favourably with those of island countries engaging in sugar production, and the overall East Africa population density compares favourably with the continental sugar growing countries. Even taking into account the obvious shortcomings of such a comparison of population densities, it is supporting evidence for a conclusion that at present, the opportunity cost of land is lower in East Africa than in most sugar growing countries.

F. Opportunity Cost of Labour and Labour Productivity

The opportunity cost of labour in East Africa is indicated by the very low per capita gross domestic product of £24.[11] Assuming an average family size of five, the average family income would be £120. The marginal opportunity cost of employing labour in terms of foregone income is probably somewhat lower than this, but one must take into account other costs of employing labour. Sugar labourers are often highly transient, coming from upcountry to the plantation for a few years in order to earn and save a lump sum to pay for bride wealth, bicycles, tin roofs for their homes, etc.[12] Transient labour involves transport costs and the cost of continual recruitment. Housing, medical care, and other amenities must be

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11. Gross Domestic Product data from Government of Kenya, *Op. cit.* Table 127, p. 100; Uganda Government, *Background to the Budget 1964-65,* Entebbe, Government Printer, 1964, p. 2; and The United Republic of Tanganyika and Zanzibar, *The National Accounts of Tanganyika, 1960-62,* Central Statistical Bureau, Dar es Salaam, 1964, p.9.

12. Walter Elkan in *Migrants and Proletarians: Urban Labour in the Economic Development of Uganda,* London, Oxford University Press on behalf of the East African Institute of Social Research, 1960, p.131writes of migrant labourers in Uganda: "Their purpose, or target, in seeking employment is not to enjoy an immediate increase in their standard of life, but rather to save as much as possible in a more or less given time with which to increase the productivity of their farms. They save to be able to buy a waterproof roof for their houses and storage sheds, to acquire large, solid bicycles on which to carry their crops to market, or to be able to pay the bride wealth for wives whom they will expect to do the major part of the work in the fields." See also pp. 42-43 and pp. 135-136.

provided on the site of the plantation. The fact that work on the plantation is considered only temporary suggests that life in the home area is preferred to life on the plantation, other things being equal, which implies that a premium over and above the loss of income in the home area must be paid to induce labour to live on the plantation. The total opportunity cost of labour in East Africa, although much lower than that in developed countries, is probably higher than that in more heavily populated areas such as Indonesia, India, and Taiwan, where pressure on the land probably results in a very low marginal product of labour.

Although the opportunity cost of labour in East Africa may be quite low compared to that in many more developed areas, labour productivity tends to be quite low as well, especially for those workers on the plantation as opposed to those in the factory.[13] By far the great majority of labourers are concerned with plantation work, about 80 per cent of the workers of a typical East African sugar enterprise (which grows nearly all of its cane on the estate) are employed on the plantation. Of the plantation work force, approximately 50 per cent (about 40 per cent of the total work force) are engaged in the cutting of cane. The amount of cane cut per worker varies between something under one ton to slightly under two tons per day. The amount of cane cut per day, of course, depends on the type of cane grown, the experience of the worker, the type of transport used (rail trolley, truck, etc.,) the terrain, the amount of mechanical equipment used in handling, and finally, the number of hours worked per day. Under the best of conditions, such as those found in the flat irrigated cane fields of northern Tanganyika, nearly two tons a day may be cut by a single worker. The overall average for East Africa, however, is probably about one ton per day.

There has been little improvement in cane cutting productivity in East Africa despite the fact that plantation sugar has been produced at least since 1930. The job requires few skills; one month is the assumed learning period for the average beginning cane cutter. No substantial improvements can be expected in the near future due to increased skill.

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13. See *Report of the Board of Inquiry:* Appointed to Inquire into the Sugar Industry's Wages and Conditions of Employment, its Industrial Relations and Methods of Wage Regulation and Related Matters Affecting the Operation and Development of the Industry, mimeographed, April 1963, Second Part, p. 3.

Little productivity increase can be expected from increased effort by cane cutters because of the system under which these men are paid. East African plantations have often used the *kipande* (ticket) system. Each worker must complete a daily task which involves cutting so much cane in order to receive his day's wages. After this amount is cut, he need do no more.

Productivity in the Caribbean ranges from 2 to 3 tons per day, while in Queensland efficient division of labour and the incentive of piece rates results in an output per man day as high as 13 tons and an average output of 7 tons a day per man.[14] East African productivity compares very unfavourably.

Beyond the low cutting rates per man, one must take into account the high degree of absenteeism on the East African sugar estates.[15] On one plantation in Uganda, the average turnout is about 80 per cent of those on the muster roll. A higher percentage turnout would reduce the cost of providing housing and other amenities per man day worked.

Another large part of the work force on sugar estates consists of weeders and cultivators who comprise anywhere from about 25 per cent to 40 per cent of the plantation labour force (20 to 32 per cent of the total work force) depending on the location of the plantation. High rainfall areas tend to have a greater weed problem, while low rainfall areas where most of the cane is irrigated are less plagued by weeds. There are no available records which would enable a meaningful comparison of the productivity of weeders and cultivators, but the low productivity of cane cutters suggests that the productivity of these workers is low as well.

Besides cane cutters and weeders and cultivators (who comprise about 60 to 70 per cent of the total work force of East African sugar enterprises) most of the rest of the work force consists of people engaged in transport and in the factory. The productivity of factory workers is probably comparatively better than that of plantation workers. The work pace tends to be set by the machines used, and the atmosphere of the factory is so different from the traditional agricultural environment that new work habits and standards may be introduced more easily. The workers must be more highly

14. V.P. Timoshenko and B.C. Swerling, *op. cit.*, p. 142.

15. See *Award of the Arbitrator*, Trade Dispute between Certain Employees Represented by the Kenya Union of Sugar Plantation Workers and Their Employees, mimeographed, November 1963, p. 2.

skilled and there is plenty of room for increased performance through learning and training. In Kenya, while production of sugar went up from 20,800 tons to 32,600 tons (up 50 per cent), the numbers engaged in the factories decreased from 1831 to 1666 (down 9 per cent) between 1957 and 1961[16]. While part of this improvement may be attributed to increased capital intensity, almost certainly much of the gains have been due to better management and increased skills.

G. Capital Costs

Capital, of course, is quite scarce in East Africa and hence its opportunity cost must be high. The present day capital cost of a sugar enterprise producing about 30,000 tons of sugar per annum[17] is approximately £5 million to £6 million, depending on the nature of the terrain and vegetation, distance from sources of building materials and machinery and equipment, the capital intensity desired, and whether or not irrigation is desired or necessary[18]. Roughly one-third of the capital expense is involved in the factory building, sugar mill, and ancillary equipment, one-third is required for the preparation of the land and plantation equipment, and one-third is involved in the provision of housing, hospitals, and other facilities for the staff and work force.

If we assume an ex-factory price of £46 a ton (approximately the present fixed internal price), a capital investment of 5.5 million, an average capital life of 30 years, and an interest rate of 10 per cent,[19] then the annual value of an output of 30,000 tons would be

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16. Colony and Protectorate of Kenya, *Kenya Census of Manufactures 1961*, Nairobi, Government Printer, 1963, p.23 and Appendix, Table 1.

17. 30,000 tons per annum is the figure most generally quoted by those in the sugar industry as the minimum viable size of a sugar enterprise in East Africa.

18. Flow irrigation costs are about £50 per acre while overhead irrigation is much more expensive and costs about £180 per acre. The new Kilombero Sugar Company plantation in south central Tanganyika has a factory capable of producing 31,500 tons of sugar per annum. Most of the cane is supplied with overhead irrigation. The original share and loan capital subscribed was £3,452,500 but an additional £2,400,000 was required when it appeared that the original subscription would not be enough to cover all the initial costs. The total capital cost then was in the area of £5,850,000. See Kilombero Sugar Company, Ltd., "Circular to Members of the Company (Scheme for Proposed Financial Reorganization of the Company and Notices of Meetings of Preference Shareholders and Extraordinary General Meeting of the Company)," 9th March, 1964.

19. The dividend rate on preferred shares listed on the Nairobi Stock Exchange in 1964 was in the range of 14 to 20 per cent. Local bank loan rates start at about 8 or 9 per cent for good risks and run much higher. Thus a ten per cent return on the capital does not seem to be an unreasonable estimate of the opportunity cost of capital.

£1,380,000 and the annual capital charges would be £458,333 or about 33 per cent of the total value of output.

Although the direct capital costs are quite large, there are almost no indirect capital costs involved in the sense that no large investments are required for the provision of intermediate goods and services as inputs into the sugar industry. Nearly all the output of the industry represents value added; purchases of intermediate goods and services are quite small compared to most other industries. The major intermediate purchases are fuel, fertilizers, and chemicals. Most of these are imported. On the basis of data compiled in the Tanganyika Industrial Census of 1961, total intermediate costs probably run about thirty per cent of the total value of output.[20]

H. Import Costs

Some of the capital cost of a sugar enterprise involves purchases of capital equipment from abroad. Of the £5 million to £6 million capital investment for a 30,000 ton per annum sugar establishment, perhaps £2 to 2.4 million or roughly 40 per cent of the total capital cost represents imports.[21] The recurrent cost of imports is quite small, consisting of fuels, fertilizers, chemicals, and tools and spares, roughly about 15 per cent of the total value of output

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20. See Republic of Tanganyika, *Industrial Census, 1961*, Government Printer, Dar es Salaam, 1964, p. 27. The cost of intermediate inputs is estimated at 36.5 per cent for the sugar processing industry. It is obvious, however, from the magnitude of the wage bill that the figures given for the sugar manufacturing industry by the largest sugar company in Tanganyika (which was responsible for over 90 per cent of Tanganyika's sugar output) refer to the whole operation (cane production plus sugar production). Some of the smaller producers gave returns which referred only to factory operations and placed an implicit value on their cane which they counted as an intermediate input. Thus the cost of intermediate inputs is somewhat overestimated in the Census and is probably in fact about 30 per cent of the total value of output (excluding excise duties).

21. These import estimates are very rough and based on an assumption that one third of the total investment relates to the factory (of which one-third is assumed to be in construction and the rest in machinery and equipment) one-third to the plantation (of which one-third is assumed to be in machinery and equipment and the rest in construction, i.e., clearing land, provision of roads, bridges, etc.) and one-third to the provision of housing, medical facilities and other amenities for the labour force (of which 10 per cent is machinery and equipment and the rest building and construction). It was also assumed that 65 per cent of investment in machinery and equipment represents imports and 25 per cent of investment in building and construction represents imports. These latter percentages are based on work done by Paul G. Clark in "The Rationale and Use of a Projection Model for Uganda," Paper EDRP 39, East African Institute of Social Research, Kampala, 1964 (mimeographed), Table 2, and in "The Tanganyika Plan: A Statistical Projection Model," Paper EDRP 56, East African Institute of Social Research, Kampala, 1964, (mimeographed), Table 2.

(half of purchases of intermediate goods and services). A rough estimate is about £200,000 for a producer with a grosss output of £1,380,000 (30,000 tons)[22]. Part of the reason for the low recurrent costs of imports is that fuel purchases are kept to a minimum by the use of bagasse, a waste material consisting mostly of cane fibres, as a fuel for the sugar mills. Over 90 per cent of the bagasse is often used for this purpose.

J. Skilled Manpower Requirements

The sugar industry is not one with a highly complicated technology, requiring highly skilled technicians, scientists, and engineers. Nearly all jobs, with few exceptions, involve skills which can be learned on the job and require relatively little formal education. There may be considerable difficulty, however, in the initial training of a cadre of semi-skilled and skilled labourers such as maintenance men, mechanics, fitters, welders, vehicle drivers, machine attendants, etc. There is no large pool of workers in East Africa possessing these or similar skills to any great degree. In the construction phase also skilled labour may be a problem as trained erectors and construction engineers and foremen are required.

While the sugar industry does not require large amounts of highly trained technical personnel, the costs of operation are highly dependent on the managerial talent. The co-ordination and planning of the work is extremely important in order to obtain efficient utilization of the labour force and machinery and equipment, especially with regard to harvesting and transport. Any large scale expansion of the industry will probably require a substantial influx of expensive trained managerial talent.

K. Real Costs

East Africa is probably a low cost producer relative to most other sugar producing countries. Yields are among the best obtainable with similar techniques elsewhere. Although the opportunity cost of capital, especially foreign capital, and managerial talent is quite high, the same is true in many of the other sugar producing countries, especially the less developed ones. In some of the less

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22. These estimates were based on the 1961 Kenya and Tanganyika manufacturing censuses, *op. cit.*

developed sugar producing countries, over-population is a particular problem which raises the opportunity cost of land.

In many of the sugar producing countries, labour productivity is considerably higher. The low productivity of labour in East Africa, however, is probably more than compensated by the low opportunity cost of labour. If we take average per capita incomes as a rough measure of the relative opportunity cost of labour and assume that cane cutting productivity in Australia, Cuba, and East Africa is 7 tons, 3 tons, and 1 ton, respectively, then the labour cost per ton of cane cut in Australia is nearly three times that in East Africa, and in Cuba it is nearly twice that in East Africa.[23]

L. Markets for Expanded Production

Our analysis in Chapter III indicated that one can expect a rapidly growing internal market for sugar. The overall rate of growth of consumption for East Africa can be expected to average about 7 per cent. Unless production is expanded at least as rapidly, imports will increase, adding to the drain on foreign exchange reserves. This expansion of consumption can be expected given the present consumer price which results from an ex-factory price of about £46 a ton. Taking the average of the two estimates of consumption for 1970 in Table III-3, the ex-factory value of sugar consumption in 1970 should be about £18 million or an increase over 1963 of about £8 million.

Expansion for the export market is a different matter. The price that can be obtained for exported sugar depends on the quota which can be negotiated under the Commonwealth Sugar Agreement (CSA). At present East Africa has a 10,000 ton quota. About half of this can be sold at the negotiated CSA price. The other half

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23. Average per capita Gross Domestic Product at factor cost for these countries is:—

					U.S.$
Australia	..	..	..	..	1215
Cuba	..	..	..	..	379
East Africa					
Kenya	..	..	..	..	85
Uganda	..	..	..	..	65
Tanganyika	..	..	..	..	52

Source: United Nations Statistical Office, *Yearbook of National Accounts Statistics 1962*, Part D, Table 3. Using population data from the United Nations, *Demographic Yearbook 1961*, the East African per capita gross domestic product at factor cost works out to U.S.$ 64.

can be sold to the U.K. at the world market price with imperial preference tariffs. Hopefully, the CSA quota can be renegotiated if the East African countries have a substantial exportable surplus. In any case, at least part of the exportable surplus will be subject to a fluctuating and probably lower world price (see Table II-8 for an indication of recent movements in the world sugar price). The fluctuations in the world price could be mitigated if the currently moribund International Sugar Agreement (ISA) could be revived. The ISA agreement of 1953 attempted to stabilize the world free market price between 3.25 and 4.35 U.S. cents per pound (£26 and £34.8 per ton) f.a.s. Cuba by adjustment of the level and distribution of quotas.[24] If it were possible, however, to achieve an exportable surplus of 100,000 tons and if it were valued at £30 a ton on the average, then the export market could be worth £3,000,000.

The CSA present quota and hoped for expanded quota would require the export of raw sugar. Most of the mills in East Africa do not produce a raw sugar for further refining but process the sugar directly from the cane into a semi-refined sugar called mill-white or plantation-white. Raws could be produced by the East African mills although they would be produced more efficiently by factories specifically geared to producing raw sugar.

There may also be possible export markets for the mill-white sugar currently being produced. Aden, Zanzibar, Saudi Arabia, and Yemen are possible markets well situated with respect to East Africa. These countries do not produce much sugar of their own and are unlikely ever to do so on a large scale. The market in these countries was about 128,000 tons in 1959 (see Table V-5) and is probably growing rapidly as is the case in most low-income countries. The former Federation of Rhodesia and Nyasaland and the Sudan also offer possible export markets. The market of the former Federation is not as large as that indicated in Table V-5. Much of the consumption is of refined sugar originally imported as raws and refined locally. The raw sugar imports in any case fall under the CSA. The breakup of the Federation and the common market, however, means that Zambia and Malawi are possible export markets for mill-whites. The Sudan also offers a very large potential market. A large expansion of sugar production is planned in

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24. V.P. Timoshenko and B.C. Swerling, *op. cit.*, p. 324.

TABLE V-5
Production and Consumption of Sugar in Selected East African Neighbours, 1959
('000 long tons)

	Production	Consumption
Aden	—	48.2*
Saudi Arabia	—	55.0
Yemen	—	18.0
Zanzibar	—	6.8
Federation of Rhodesia and Nyasaland	11	74.0
Sudan	—	125.0

* Includes local consumption, 25.0 thousand tons, plus 23.2 thousand
tons of re-exports, mostly as ship's stores.

Source: Food and Agricultural Organization, *The World Sugar Economy in Figures, 1880-1959*, Rome, 1961, p. 30 and pp. 104-105.

Zambia and the Sudan, however, and both plan to become self-sufficient in the next decade or so. In the meantime, though, imports will continue, and East Africa may be able to export substantial quantities of sugar before these countries reach self-sufficiency.

Finally, East Africa may be able to export some refined sugar although none at present is being produced. The factories at Kilombero in Tanganyika and Miwani in Kenya contain refineries and are capable of producing refined sugar if the market warrants it. At present there is little incentive to produce refined sugar because of the lack of a price differential between refined and mill-white sugars.

There should be little problem in marketing most of the East African exportable surplus at a reasonable price. As long as East Africa remains in the Commonwealth, Britain should expand the East African quota if a surplus arose. Half of the CSA quota could be marketed at the negotiated CSA price while half would be used at the prevailing world free market price. Any sales beyond the CSA quota would probably fetch the prevailing world market price. It is difficult to say whether the marginal social return of selling beyond the CSA quota would be sufficient to cover the marginal social costs because of the uncertainty of world prices and the lack of good cost data for sugar manufacture.

M. Diversification of Exports

One consideration that cannot be overlooked in discussing the benefits of an expansion of the sugar industry is the possibility for diversification of exports, considering the narrow range of products currently being exported from East Africa. The major exports of East Africa for 1960-62 are listed in Table V-6. Four

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TABLE V-6

Major Commodity Exports of East Africa, 1960-62

	Kenya Exports (£'000)	Per Cent of Total	Uganda Exports (£'000)	Per Cent of Total	Tanganyika Exports (£'000)	Per Cent of Total	East Africa Exports (£'000)	Per Cent of Total
1. Coffee, unroasted	31,463	29	51,140	43	20,633	13	103,266	27
2. Cotton, raw	1,906	2	39,906	34	23,014	15	64,826	17
3. Tea	13,604	13	4,922	4	4,100	3	22,626	6
4. Sisal	13,081	12	131	—	45,204	29	58,416	15
5. Pyrethrum & pyrethrum extract	9,264	9	—	—	254	—	9,518	2
6. Maize; maize meal & flour	1,304	1	251	—	1,820	1	3,375	1
7. Hides & skins	4,704	4	3,138	3	5,086	3	12,928	3
8. Sodium carbonate	4,145	4	—	—	—	—	4,145	1
9. Copper	1,443	1	10,267	9	—	—	11,710	3
10. Cashew nuts	740	1	—	—	5,546	4	6,286	2
11. Gold	370	—	19	—	3,750	2	4,139	1
12. Wattle bark extract	2,220	2	—	—	1,089	1	3,309	1
13. Feeding stuff for animals	691	1	3,976	3	2,327	2	6,994	2
14. Meat & meat preparations	6,886	6	16	—	6,316	4	13,218	3
15. All others	18,609	17	4,651	4	35,623	23	56,853	15
TOTAL	108,430	100	118,417	100	154,762	100	381,609	100

Source: East African Common Services Organization, East African Customs and Excise, *Annual Trade Report of Kenya, Uganda, and Tanganyika* for the years ended 31 December, 1960, 1961, and 1962, Mombasa, Commissioner of Customs and Excise, *passim*.

commodities, coffee, cotton, tea, and sisal accounted for 65 per cent of all exports of the East African countries. These commodities plus meat, hides and skins, pyrethrum, cashew nuts, copper, and animal feed accounted for 80 per cent of all exports. Uganda, in particular, has a high degree of dependence on a few export commodities. Over 77 per cent of its export revenue is from coffee and cotton alone. A vigorous expansion of sugar production could make it one of the top ten or fifteen export earners during the next decade. As Uganda already is more than self-sufficient in sugar production, an expansion very quickly would have a diversifying effect on exports.

Relatively few other commodities offer the same possibility for diversification of exports. The export of sugar would be particularly attractive if a substantial increase in the CSA negotiated price quota can be obtained. The export price of sugar would then be relatively stable and could contribute to the overall stability of export prices.

N. By-products

Other possible benefits accruing to sugar production in East Africa may be those derived from the production of sugar by-products. The molasses derived from sugar production may be used directly as cattle feed, or to produce alcohol and spirits, acetone and butanol, citric acid, lactic acid for human nutrition, dried yeast, and other chemical products. The fibrous waste resulting from the grinding of cane, called bagasse, may be used as the major raw material component of insulating and hardboard products for the building industry, corrugated or flat boards for shipping cartons, roofing tiles, low quality papers such as wrapping paper and newsprint, furfural, and other products. Sugar cane wax, recovered from filter muds, may be used in shoe wax, carbon paper, floor wax, and other wax products. Other fatty acids recovered from the filter mud may be used in soap making[25].

The economic viability of the production of these products, of course, can only be assessed after a careful analysis of the costs and the availability of markets. Some by-products, however, are

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25. For a discussion of the technical possibilities of producing sugar by-products, see Walter Scott, *The Industrial Utilization of Sugar Cane By-products*, Port-of-Spain, Trinidad, Caribbean Commission, 1950.

already being produced and sold by East African sugar manufacturers. The internal market for cattle feed is not sufficient to use up all the surplus molasses, and previous to 1964, most of the molasses by-product was either used in the manufacture of alcohol or spirits, or used on roads as a light sealing agent. In 1964, however, one large sugar producer in northern Tanganyika, the Tanganyika Planting Company, began to export molasses as cattle feed at the rate of about 20,000 tons per year[26]. If export proves successful, other manufacturers who are located relatively close to the ocean ports may follow suit. Future increases in sugar production near the coast may also result in increased exports of molasses.

Two sugar manufacturers, one in Uganda and one in Kenya at Miwani, are using a portion of their molasses in the production of alcohol. Their combined capacity of 1900 Imperial gallons per day is more than sufficient to cover the local demand. Alcohol produced in Uganda is sold mostly as medicinal spirits while the Kenya production is sold mostly to alcoholic beverage distilleries in Nairobi.

Most of the bagasse (about 90 per cent) resulting from sugar production in East Africa is used as fuel to power the mills. If the bagasse were to be used as a raw material for building products, then imported diesel fuel would be necessary to replace the bagasse used as fuel.

A study of the viability of manufacture of other products from bagasse, molasses, and materials recovered from filter muds in East Africa would be desirable.

O. Employment Objectives

Sugar production involves relatively large amounts of labour. A sugar plantation and factory producing 30,000 tons of sugar per annum can expect to employ about 2,500 workers or approximately one worker for every eight tons of sugar per annum[27]. If we assume

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26. *SPEAR*, the magazine of East African Railways and Harbours, Vol. 6, No. 11 (October 1964), p. 272.

27. Four of the East African producers, whose total output of sugar in 1963 was 111,026 tons, employed 12,328 men. Adjusting the number employed to account for the fact that some of the cane used by these manufacturers was purchased from outgrowers, we arrive at a figure of 13,472 as the total employment assuming that all cane is produced on the plantation. This comes to one man per 8.2 tons of sugar per annum. The range of variation in the number of tons of sugar produced per man is 7.8 to 8.4 tons of sugar per worker for the three large producers for whom returns are available.

that the capital investment for a 30,000 ton sugar enterprise is £5.5 million, then the amount of capital per worker is £2,200. In a recent survey conducted by the East African Manufacturers Association, the average capital employed per man was estimated to be £2,230[28]. An inquiry was sent to 100 members of the association. Replies were received from 38 concerning capital and labour employed. For these 38 respondents, the capital employed was £44 million and the number of workers was 19,626. The range of variation in the capital/labour ratio was £1,000 to £50,000. The value of capital was determined on an original cost basis. The average capital/labour ratio of £2,230 would be substantially larger if a present day cost basis was used. Thus the average present day capital/labour ratio of £2,200 for the sugar industry is probably low compared to most other industries.

In view of the implied or explicitly stated employment objectives of the current development plans of the three East African countries,[29] a low capital/labour ratio ought to be one of the criteria in determining the desirability of the expansion of an industry[30].

P. Outgrower Scheme

Although an expansion in sugar output would necessarily mean an expansion of large scale plantation agriculture, the peasant farmer, predominant in East Africa, may derive significant benefits as well, provided that there is at the same time an expansion in outgrower schemes. Some of the present East African manufacturers are already purchasing significant amounts of their cane from outside farms, some of it from peasant outgrowers and some from larger-scale, mostly European and Asian, farms. One large manufacturer in Uganda purchases about 15 per cent of his cane from peasant outgrowers. The manufacturer offers to clear the land and provides

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28. *East African Trade and Industry*, Vol. 10, No. 122 (April 1964), p. 13.

29. The Kenya development plan (Government of Kenya, *Development Plan 1964-1970*, Nairobi, Government Printer, 1964) envisages a rate of growth in employment between 1962 and 1970 of 2.8 per cent from 581,300 to 725,600. This compares with the 1954 to 1962 rate of growth in employment of 0.8 per cent while the Gross Domestic Product at current prices rose at the rate of 5.5 per cent (pp. 11 and 135).

30. The use of the capital/labour ratio as a criterion in development planning has been much criticised (See, for example, Walter Galenson and Harvey Leibenstein, "Investment Criteria, Productivity, and Economic Development," *Quarterly Journal of Economics*, Vol. 49 (1955), p. 343, but we feel that a knowledge of the capital/labour ratio is desirable for planning purposes provided its limitations are realized.

the seed cane to the peasant growers. The new factory at Muhoroni in Kenya is expected to purchase 75 per cent of the cane processed from outgrowers. The present factory in the same area purchases about 30 per cent of its cane from outgrowers. The sugar factory at Ramisi on the coast of Kenya purchases cane from the Shimba Hills Settlement Scheme nearby. The mill in the Kilombero Valley of Tanganyika also crushes outgrower cane as well as estate grown cane. The average price paid for outgrower cane ranges from Shs. 40/- to Shs. 47/- per ton.

Yields per acre for peasant grown cane can be expected to be lower than estate yields. With an average yield of 15 to 20 tons per acre over an 18 month growing cycle, and an average price of Shs. 40/- to Shs. 45/- per ton, the cash yield per acre would range from about £20 to £30. This compares very favourably with average cash yields per acre for most other crops. Some very crude estimates of average yields per acre in peasant cultivation of some selected crops are £23 for coffee, £7 for cotton, £40 for tea, £25 for bananas, £24 for rice, £22 for cassava, £18 for lentils, £15 for groundnuts, £12 for soya bean, £10.5 for cashew nuts, £7.5 for sesame seed, £6 for pigeon peas, and £3.4 for grams[31]. Acreage yields of course conceal great differences in the amount of labour required for cultivation, differences in the amount of waiting time necessary before harvesting can take place, and the fact that some crops may be interplanted with others giving a higher combined yield per acre. Tea and coffee, for example, require waiting periods of several years duration before any crop can be harvested.

Q. Comparison of Real Costs and Benefits

Most of the evidence points to the conclusion that a vigorous expansion of the sugar industry should be pursued. This conclusion needs to be verified by a more careful analysis of the cost structure of the industry, requiring a proper evaluation of the opportunity

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31. These are very rough estimates of yields per acre derived from information on physical yields and average prices given in L.H. Brown, *A National Cash Crops Policy for Kenya*, Nairobi, Government of Kenya, 1963, pp. 87, 97, 103, 110, 120, 123, 126-130, 132; E.M. Chenery, *An Introduction to the Soils of the Uganda Protectorate*, Department of Agriculture, Memoirs of the Research Division, Series I (Soils), No. 1, Kampala, 1962, p. 54; and in *The Economic Development of Kenya*, Baltimore, The Johns Hopkins Press for the International Bank for Reconstruction and Development, 1963, pp. 122-123.

costs of capital, foreign exchange, and skilled labour. It would be surprising, however, if such a thorough investigation would lead to any other conclusion. The natural conditions giving high yields per acre compared to other countries, the labour intensity of sugar production, the foreign exchange savings and earning possibilities, and the suitability for outgrower schemes with attractive returns to peasants are particularly attractive features of the sugar industry.

CHAPTER VI

SOME POLICY ISSUES AND THE FUTURE
OF THE SUGAR INDUSTRY

The relationship between private costs and benefits, as opposed to that between social costs and benefits as discussed in the last chapter, is to a large extent determined by government policy. Prices to the manufacturer are controlled by government in East Africa. Government allocation of import and export licences may affect the return to the manufacturer. Government rules and regulations and attitudes towards the purchase and sale of land affect the cost and availability of land for expansion of sugar output. Government attitudes towards minimum wages and strikes and labour unions affect labour costs. Government policy concerning investors such as provision of tax holidays, tariff protection, loan guarantees, and encouragement and information for investors all affect private returns as well[1].

A. The Ex-factory Price

The ex-factory price of sugar is fixed by law in East Africa (see Table II-7). Three policy alternatives are open: (1) continuation of the present fixed price, (2) resort to free market pricing with perhaps some tariff protection, and (3) a new government fixed price.

A reduction of the present fixed price will certainly have an adverse effect on private plans for expansion of the sugar industry. Our conclusion in Chapter III was that consumption is relatively inelastic with respect to price changes and certainly less than unity, so that a reduction in price would result in a reduction in revenue even if more output could be produced and sold at the lower price.

The return on capital demanded by foreign and local investors is quite high, especially since the gestation period before a sugar factory can be established and running smoothly is quite long. The

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1. In addition to these aspects of government policy, payment of premiums to the manufacturer for improved sugar quality should be considered. This subject, however, was dealt with more thoroughly than the author of the present work could hope to do in a report by Dr. K. Douwes Dekker to the East African governments on sugar quality in East Africa (mimeo).

starting of a new sugar enterprise is fraught with initial difficulties[2].
A lower price would prolong the waiting period before profits
begin to be realized. Once the plantation and factory are well
co-ordinated and running at or near capacity, profits may be con-
siderable, but if it is felt by the governments that profits are excessive,
a different policy on the taxation of profits may be in order. A
reduction in the ex-factory price to reduce sugar manufacturers'
profits, however, would have the undesirable effect of a greater
reduction in the incentive to increased production than would
increased taxes. The effect of increased taxes would be delayed and
only begin to take effect once profits were being made.

It might be argued that a lower price is the desirable way to
reduce sugar profits of established producers and that tax holidays
could be given to prospective investors. There are two questionable
aspects of this policy. First of all, the existing producers are potential
investors in both existing and new plantations and factories. There
is no reason why they should be discriminated against. In fact,
in view of the shortage of trained managerial talent in East Africa
and in view of the present manufacturers' knowledge of conditions
and experience of operating in East Africa, these people should
be given every encouragement to expand their activities. Secondly,
a tax holiday will not have nearly the same effect as a high fixed
price. As long as profits are not forthcoming, a tax holiday is useless.
A high price, on the other hand, can shorten the time at the beginning
during which no profits are made.

The alternative to fixed ex-factory prices is to let the price of
sugar fluctuate according to free market forces. This would mean
effectively that the price in East Africa would be dependent on the
widely fluctuating world free market price (see Table II-8). The
world market is so "thin", however, that it is hard to make a case

2. The Kilombero Sugar Company in its first Annual Report (1962/63)
complained that "due to a number of teething troubles in both field and factory
the period of production in both field and factory was longer and the costs of
production rather higher than we had expected: in consequence the loss sustained
on the year's operations was higher than we had expected . . . For the 1963/64
grinding season we estimated a crop of 22,152 long tons: we now expect a crop
of 12,500 long tons. Our Managing Agents . . .attribute this sudden and alarming
shortfall to a number of factors, but principally mistaken agricultural assump-
tions—some of which go back to the original planning of Kilombero as to the
age at which cane is in the best condition for harvesting . . . (We) cannot yet
give the shareholders any indication as to when they can reasonably expect a
dividend . . ." (p. 4).

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that this price is a meaningful indicator of the real benefits of sugar production. Most of the sugar sold internationally is sold on a negotiated price basis as is done through the Commonwealth Sugar Agreement and other bilateral or multilateral purchase agreements.

In view of the initial difficulties in setting up a sugar enterprise and of the possibility for increased performance over time as managerial experience is obtained,[3] the sugar industry should qualify under the infant industry argument for some sort of protection. Tariff protection with free market pricing would have the undesirable aspect of widely fluctuating and unrepresentative prices. Income tax holidays or rebates are not very effective in providing an incentive to expansion because of their delayed effect. The granting of subsidies would not have this same defect but is probably politically unfeasible. The present practice of fixing the internal price at a high level, independent of the world market price, and maintaining this price by quantitative restrictions on imports and exports seems to be the best solution given the circumstances.

B. Export and Import Policy

Combined with a policy of import and export restrictions and a fixed internal price must be a co-ordinated East African policy with regard to distribution of import quotas and export quotas. In the past importation has been conducted by the Kenya and Tanganyika governments (Uganda has had a surplus for a good many years). The governments have made substantial profits on the importation of sugar whenever the world price was significantly lower than the fixed internal price, which was the case for most of the period from 1955 to 1963. Of course the governments have been liable to losses on importation whenever the world price was above the fixed internal price. This situation, however, has been more rare, and the governments unexpectedly found themselves making losses when world prices rose substantially in the spring of 1963.

When and if East Africa becomes a substantial exporter of sugar, the governments may also want to pursue the same policy with respect

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3. The Tanganyika Planting Company has made fantastic gains in productivity over the last decade. Yields per acre have increased 50 per cent between 1956/57 and 1962/63. The rate of water utilization has increased about 164 per cent between 1955 and 1962, from 110 tons to 280 tons of sugar per cusec of water. As water on the TPC plantation is a scarce commodity this increase in water productivity has permitted a substantial increase in output. The increased productivity has been due in part to increased capital intensity, but a large part has been due to increased knowledge and better management.

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to exports, i.e., conduct all exportation through government auspices. The governments must be willing, however, to take losses when the world price is lower than the internal price. If past history is any indication, then the governments can expect to incur losses more often than profits on exportation.

Alternatively, the manufacturers themselves or agents of the manufacturers can do the exporting upon the grant of an export licence by the governments. When the world price is higher than the internal price, exportation at the higher world price would be more profitable than internal sales; thus export licences would be a very valuable commodity. Some distribution of licences among the manufacturers which the manufacturers themselves thought equitable would be necessary. Otherwise there would be a very potent incentive to evade the law in some way in order to get a share of the export market. As we indicated in Chapter IV, economic distribution and marketing of sugar requires that those manufacturers which are closest to the ports or which produce the desired grade and quality of sugar should be the ones to export. Distribution of export licences on these economic criteria is bound to be met by objections on the part of those manufacturers who are not well situated with respect to exports when export prices are high. The Uganda producers, for example, would probably be ruled out as exporters on any economic criteria. In order to get a share of the export market the Uganda producers and the Uganda government may withdraw from any agreement for co-ordination of distribution of sugar by the three East African countries and export the Uganda surplus independently. The result would be an uneconomic distribution of sugar and a waste in transport costs (see Chapter IV).

If the manufacturers were required to export themselves or through their agents, then when the world market price was lower than the internal price, internal markets would be more desirable. The likely result would be either price cutting until the internal price reached the export price or an agreement among manufacturers on shares of the East African market with each producer being required to export any surplus over and above its share. Here again export probably would not take place on any economic criteria and the distribution of sugar would be wasteful of transport costs.

Government losses could be avoided and an economic allocation of export markets could be achieved if either the manufacturers

or the government are willing to set up a price equalization fund. Each producer would receive the same price (taking into account differences in quality) no matter where each sold his sugar. A producer would be required to contribute to the fund if the price which he received were above the average price received during a given year. Payments would be made from the fund to those producers who received prices which were below the average price. In this way no producer would have an incentive to export when export prices are high and sell internally when export prices are low. Sugar could be distributed on an economic basis with a minimum of transport costs.[4]

C. Geographic Price Differentials

At present the consumer price in East Africa varies according to geographic location. Geographic differentials are in line to a certain extent with differences in transport costs (see Chapter II)- As long as the ex-factory price is fixed, price differentials in accord. ance with differences in transport costs are necessary to induce traders to purchase from the factory and transport and sell the sugar in different and sometimes remote areas. Geographic price differentials also encourage an economic location of new sugar plants.

Geographic price differentials in East Africa are either fixed by law as in the case of Kenya or suggested by the ministry responsible for commerce. Thus geographic differentials are fairly rigid. Rigid geographic price differentials tend to result in the uneconomic allocation of the product sugar. For example, when the Kilombero factory was not able to produce as much sugar as expected during the 1963-64 grinding season, the southern area of Tanganyika demanded more sugar than the Kilombero factory could supply. Traders were unwilling to bring sugar from the Arusha Chini factory in northern Tanganyika to the southern areas since the price differential made it unprofitable to carry sugar that far. Thus the southern part of Tanganyika went without sugar for long

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4. A price equalization fund of the sort outlined in this chapter would make it possible both to have an economic distribution of sugar and to save the government from incurring any losses on the exportation of sugar. Any of the three countries, however, whose ratio of exports to domestic sales of sugar under autarchy would be less than the average ratio for all three East African countries could profit by pursuing autarchy in the sense that the total revenue to local producers will be higher at the same time local consumers pay no more for their sugar. Cf. the discussion in Section C of Chapter I.

periods and buyers there were unable to bid the price up to attract sugar from the north because of government price supervision. Rigid geographic price differentials make it unprofitable for traders to ship sugar from temporary surplus areas to temporary shortage areas which result from disruptions in the usual patterns of production and distribution.

D. Labour Policy

Since wages are a large part of the costs of sugar production, the profitability of investment in sugar is highly dependent on labour costs. Factors affecting labour costs of the sugar industry may be divided usefully into four categories: (1) wage rates, (2) provision of housing, medical, and other amenities, (3) costs of recruitment, and (4) the incidence of absenteeism and work stoppages due to labour strife. The basic wage rates in the sugar industry in 1964 were quite low, about Shs. 100/- per month for unskilled workers.[5] This contrasts with a minimum wage of Shs. 120/- in Uganda and Shs. 150/- in Kenya and Tanganyika in 1963 for urban unskilled workers. The relatively low wage to sugar workers, however, conceals the fact that free housing and medical care are provided on the plantation, in addition to free primary education for children of sugar workers in many cases, recreational facilities, and a number of other amenities. Urban workers, on the other hand, are not usually given such amenities. The capital cost of provision of housing, health, educational, and recreational facilities is very high. It is usually estimated to be about one-third of the total capital cost of a large scale sugar enterprise.

The relatively low wage rate, however, means that workers on some plantations tend to be transient. Most of the sugar plantations are either in areas where the annual income of a peasant family is above average or in areas which are remote and sparsely populated. A wage of £60 a year is not enough to attract the relatively wealthy peasant farmers. For example, in Uganda the two large existing plantations are in Mengo and Busoga districts. The 1963 per capita incomes of these districts may be estimated at about £28 and £18,

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5. Plantation cane cutters monthly wages were Shs. 91/- in Kenya (plus about 5 per cent gratuity for a full unbroken calendar year of service), Shs. 105/- in Uganda, and Shs. 111/- in Tanganyika in January 1964. See *Wages and Conditions of Employment in the Sugar Industry*, African Research Office, International Confederation of Free Trade Unions, Kampala, March 1964, Appendices Nos. U.S.1, K.S.2, and T.S.3.

respectively.[6] Assuming an average size of five, family incomes would average £140 and £90, respectively. Even considering the fact that wives and juveniles of sugar plantation workers may work and earn a bit of extra money on the plantation, and that the average family income is probably above the opportunity cost of peasant farming, it would seem that the annual unskilled wage of £60 a year would have to be quite a bit higher in order to attract large numbers of the local population. Consequently, many of the sugar plantation workers come from northern Uganda where the returns to peasant farming are much lower. West Nile district has been a significant source of plantation workers in Uganda. Here average per capita income in 1963 was about £11 or a family income of £55, assuming a family of five.[7] The transient nature of a large proportion of sugar workers means that recruitment costs tend to be quite high.

While data on wage costs (excluding costs resulting from labour unrest) in the sugar industry are sparse, what little evidence there is points to a rather moderate rate of increase over time (at least as regards the sugar plantation workers as opposed to the sugar factory workers) compared to manufacturing and service industries. This is probably due to two factors: (1) sugar plantation workers in all three East African countries have been exempt for the most part from minimum wage legislation, and (2) union recognition and collective bargaining are still in their infancy. Statutory minimum wages in East Africa, with the exception of Tanganyika since 1962, apply only to urban areas.[8] In 1962 the minimum wage was set

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6. Official estimates of per capita income (cash plus subsistence) in 1959 were (see Chapter II, Section B):

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Mengo ..	..	..	..	..	26.3
Busoga ..	..	..	..		16.6

Between 1959 and 1963, Gross Domestic Product (at factor cost) grew 18 per cent and population grew about 10 per cent. Adjusting the 1959 district figures upward by 8 per cent, we get £28 and £18.

7. Per capita income for 1963 was 1959 official estimate (see Chapter II, Section B) adjusted upward by 8 per cent (see previous footnote).

8. In March 1961 minimum rates were established for Kenya's agricultural workers at Shs. 51/50 per month not by law but by agreement between the Kenya National Farmers Union and the General and Agricultural Workers Union. Sugar plantation workers were not covered by this agreement. In the latter part of 1963, a board appointed by the Kenya Ministry of Labour was to consider the establishment of a statutory minimum wage for rural areas. An *ad hoc* committee was appointed by the Uganda Ministry of Labour during the latter half of 1964. The report of this committee had not been published by March 1965 but there was speculation that the committee might recommend a minimum wage for rural areas.

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at Shs. 100/- for agricultural workers in Tanganyika while at the same time the urban minimum wage was set 50 per cent higher. The average wage on Tanganyika sugar plantations is somewhat higher than in Kenya and Uganda partly as a result of the application of minimum wages. There is little evidence that minimum wage legislation in Kenya and Uganda has had any very direct effect on wages of sugar plantation workers, although it would be difficult to show that a constantly rising minimum wage will not have some long run effects on the general level of wages in industries not covered by minimum wage legislation.

Formal union recognition by the sugar industry has been relatively recent. For example, talks began only in 1960 between the Kenya Sugar Employers Union and the Kenya Union of Sugar Plantation Workers.[9] In 1961 the Kenya Union was formally recognized and a wage agreement signed. Checkoff of dues of Kenya union members did not occur until December 1963 as a result of recommendations of a Board of Inquiry.[10] Tanganyika Planting Company entered into its first formal wage agreement with the Tanganyika Plantation Workers Union in October 1959.[11] Checkoff of dues was applied to plantation workers by a ministerial order of the Tanganyika Ministry of Labour in 1962.[12] A formal recognition agreement was signed between the Tanganyika Sugar Manufacturers Association and the union in September 1963.[13]

Although wages and other fringe benefits resulting in increased labour costs have probably not increased very rapidly, labour unrest and strikes during the last three or four years have probably resulted in substantially increased costs of sugar production especially in Kenya and Uganda. Labour difficulties in Uganda came to a head in the spring of 1964 when a Commission of Inquiry was appointed by the Prime Minister to look into labour unrest in the

9. *Report of a Board of Inquiry* Appointed to Inquire Into the Sugar Industry Wages and Conditions of Employment, its Industrial Relations and Methods of Wage Regulation and Related Matters Affecting the Operation and Development of the Industry, Nairobi, April 1963, p. 2.

10. *Wages and Conditions of Employment in the Sugar Industry*, African Research Office, International Confederation of Free Trade Unions, Kampala, March 1964, pp. 3-4.

11. Tanganyika Ministry of Labour, *Annual Report of the Labour Division: 1959*, Dar es Salaam, Government Printer, 1962, p.13.

12. Tanganyika Ministry of Labour, *Annual Report of the Labour Division: 1962*, Dar es Salaam, Government Printer, 1964, p.6.

13. *Wages and Conditions of Employment in the Sugar Industry*, op. cit., p. 5.

sugar industry. During 1962 and 1963 there had been seven different strikes at one of the sugar plantations (five of them between October 1962 and June 1963) resulting in a loss of 13,000 man days.[14] The other sugar plantation in Uganda was also hit by strikes during that same period, five strikes occurring between August 1963 and January 1964.[15] Most of the strikes were over work rules and claims by the union of arbitrary dismissals and abusive treatment. Very little effort was expended in raising wages and fringe benefits.[16]

In Kenya, the discussion of 1960 leading up to the wage and recognition agreement of 1961 was far from harmonious. No date was set by the 1961 agreement for re-opening of wage negotiations. The Employers Union refused to negotiate requests for increased wages in April and again in June 1962. The management at Miwani began to negotiate contracts individually, which was a contributory factor to the strike in August 1962. The strike ended August 15 when a Board of Inquiry was appointed to make recommendations. The Board of Inquiry issued its report in April 1963.[17] Further unrest followed in the summer of 1963. A conciliator was appointed in early September, but the conciliation failed, resulting in a 20-day strike in October 1963. An arbitration board was appointed by the Kenya Ministry of Labour on October 26, 1963 and an arbitration award was made on the 30th of November.[18] Further strikes followed in the spring of 1964. About that same time the sugar company at Ramisi went into receivership. The Ramisi estate and factory were offered for sale in March 1965.

The picture presented by this short history of labour relations in Kenya and Uganda is one of almost continual labour strife over the last few years. The cost of this unrest to the employers while difficult to estimate must be considerable, both because of loss of labour time and wastage of capital and because of the time and effort required by management in settling the disputes. The increased cost certainly lessens the attractiveness of sugar manufacture to prospective investors. Without arguing the advantages and dis-advantages of various types of conciliation and arbitration by

14. *Uganda Argus*, April 1, 1964, p. 1 and June 9, 1964, p. 3.
15. *Uganda Argus*, April 11, 1964, p.3.
16. *Uganda Argus*, June 9, 1964, p. 3, and June 11, 1964, p. 3.
17. *Report of the Board of Inquiry, op. cit.*, pp. 2-4.
18. "Award of the Arbitrator of Trade Dispute Existing between Certain Employees Represented by Kenya Union of Sugar Plantation Workers and Their Employers", Nairobi, 30 November, 1963 (mimeo).

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government officials or by government appointed adjudicators, it can be stated that government can play an important role in mitigating the amount of labour strife. On the one hand management needs to be impressed with the need for firm recognition of the unions and for actions which demonstrate willingness to bargain in good faith. On the other hand, the unions in order to obtain such recognition will need to maintain good control of the workers. Most of the Uganda strikes in 1962 and 1963 were unofficial.[19] The growing strength of the unions may be accompanied by a faster growth in wage rates and additional benefits for the workers. As far as management is concerned, however, growing union strength may be accompanied by significant benefits. The number of strikes may be reduced, absenteeism lowered, and productivity increased by a strong union in control of its members. Rising wage rates and more liberal leave allowances may reduce labour turnover in the industry and significantly reduce the high cost of continual large scale recruitment.

For the factory workers, the situation is quite different than for the plantation workers who form the great bulk of the labour force. The average wage of sugar factory workers in Kenya rose nearly 63 per cent between 1957 and 1961, from £91 to £148 per annum. At the same time productivity per man rose from 11.4 tons to 19.6 tons of sugar or 72 per cent. The result has been an actual reduction in labour costs per ton of sugar produced by the factory from £8 to £7 6s. or 5 per cent.[20]

E. Land Policy

Land in East Africa is for the most part of three types: (1) freehold land, (2) tribal land, and (3) government protected forest reserves, game reserves, and national parks. Only a very small portion of the land is freehold land in East Africa. Properly surveyed, titled and marketable land in Tanganyika and Uganda probably constitutes no more than one or two per cent of the total land. It is usually impossible to purchase tribal lands because of the lack of a market, because of local tribal opposition to encroachment on traditional land, or because of legal restrictions on the purchase of tribal lands by non-Africans.
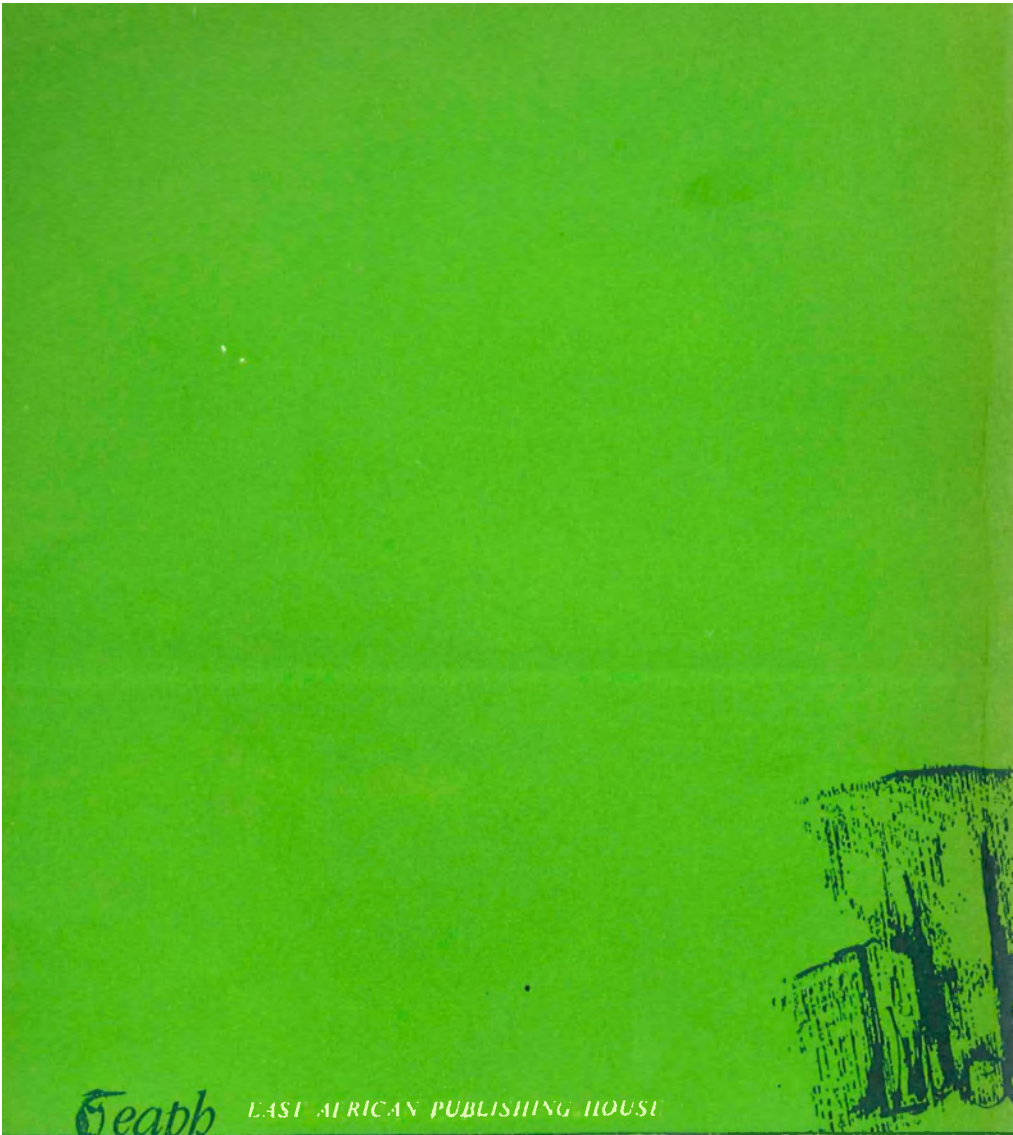
19. *Uganda Argus*, June 9, 1964, p.3.
20. Government of Kenya, *Kenya Census of Manufacturing: 1961*, Nairobi, Economics and Statistics Division of the Ministry of Finance and Economic Planning, 1963, Appendix, Table 1.

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A more liberal land policy with better title to land and encouragement of a land market would make investment in plantation agriculture easier. This, however, would have to be a long range policy, requiring an effort to educate local leaders to abandon traditional attitudes. A short run expedient would probably involve intercession by the central government to acquire suitable land on an *ad hoc* basis for prospective investors in the sugar industry.

F. Conclusions

In this Chapter we have specified some of the areas of government policy making which affect the private returns to sugar manufacturers. The two most important areas of policy making which affect the private returns to sugar manufacturers are government setting of the ex-factory price and government labour policy. These areas of policy making are equally important if the government decides to invest in government owned sugar enterprises. A sugar price which is set too low to make sugar production profitable then means that taxes will somehow have to be raised to subsidise the industry. Maintenance of good labour relations will be just as much a problem for the state enterprise as it is for private entrepreneurs.

At a time of critical reassessment in the development of the sugar industry in East Africa this book dissects the past history and performance of the industry and gives a penetrating insight into future problems and prospects.