

**MULTI-CRITERIA PLANNING FOR AGRICULTURAL DEVELOPMENT:
A FULL EMPLOYMENT STRATEGY FOR MAURITIUS**

by

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WITH modern methods of travel and communication shrinking the world almost day by day, a progressive university must extend its campus to the four corners of the world. The New York State College of Agriculture and Life Sciences at Cornell University welcomes the privilege of participating in international development — an important role for modern agriculture. Much attention is being given to efforts that will help establish effective agricultural teaching, research, and extension programs in other parts of the world. Scientific agricultural knowledge is exportable.

A strong agriculture will not only provide more food for rapidly growing populations in less-developed countries, but also a firmer base upon which an industrial economy can be built. Such progress is of increasing importance to the goal of world peace.

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FOREWORD

Whenever economic strategies for a developing country are appraised by policy makers, many different criteria are considered simultaneously before a final decision is reached. In contrast, economists using formal optimizing techniques can only identify a single criterion. Nevertheless, if this criterion is chosen carefully and meaningful constraints are applied to it, additional policy objectives can be incorporated.

Obviously, identification of an optimum policy need not imply that this policy be adopted in practice. In many situations, it is unnecessary to use optimizing techniques, as the choice between policies can be determined by "political forces." However, this procedure is not suitable for situations in which detailed decisions are required at many different levels. There is often, then, a need for economists to use optimizing techniques to limit the number of alternative policies.

Adjusting the existing pattern of agricultural production provides an excellent example of a situation in which the number of policy alternatives is almost limitless, and it is to this adjustment problem that our study of Mauritius is addressed. The specific purpose of the analytical section is to determine an optimum production pattern for agriculture using a linear programming model. The objective function chosen for the model is maximization of the balance of payments in the agricultural sector, subject to constraints of land, manpower, and specified levels of domestic consumption. The constraints on consumption ensure that an adequate and varied diet is maintained for the whole population. Policies related to trade are obviously important in a country like Mauritius, depending as it does so heavily on a single export crop; but other factors, in particular the level of employment, must also be considered. Although employment is not explicitly maximized in the model, labor is in fact utilized as extensively as possible in the optimum solution. This stems from the fact that unemployed labor is treated as a wasted resource which could be used to increase export earnings; labor intensive activities will always be selected until some other constraints are binding. This would not necessarily obtain were profit maximization the objective of the model, with labor treated as an expense.

No linear programming model can provide useful results unless the quality of input data is high--"garbage in, garbage out" is an all too frequent characteristic of econometric studies of low-income countries--and for the present study a large amount of detailed information is required. Fortunately such a data base exists for Mauritius, a tiny island of only 720 square miles in the Indian Ocean.

Mauritius is singularly suited to the study for a number of other reasons. Agriculture is the most important sector of the economy. The island has a most extreme form of a monocrop economy in which sugar cane occupies 90 percent of the cultivated land. The sugar industry occupies about 40 percent of the economically active population, and sugar and its byproducts account for about 90 percent of the value of exports and more than a third of the total output of goods and services.

Historically this export specialization has worked to the island's advantage. The level of living, by tropical standards, is high. More recently, however, the outlook for sugar has deteriorated, a reflection primarily of Britain's changing world status. Two-thirds of the Mauritius crop is marketed at premium prices under the Commonwealth Sugar Agreement. The future of these exports depends on the conditions Britain obtains for Commonwealth sugar from its new partners in the European Common Market.

About two-thirds of the food requirements of the country are imported, and since the population is expected to increase by 25 percent in the next decade, feeding it will put severe stresses on the balance of payments unless the rate of dependency on food imports is decreased. This implies a reappraisal of the agricultural policy to weigh the advantages of producing locally some of the food needed at the expense of sugar for export.

The major problem facing the island is the high unemployment rate, accentuated by the seasonality of labor requirements for the sugar industry. The unemployment rate is about 20 percent of the total labor force, and the situation will worsen unless there is considerable increase in employment opportunities. The labor force is expected to increase by more than 30 percent in the next decade.

The agricultural sector will still have to remain, at least in the near future, the main source of employment. However, the cultivable land in the island is limited. There is only one-third of an arpent¹ of cultivable land per person, and this will be reduced to a quarter of an arpent in the next decade.

Mauritius, then, is something of a bellwether for many developing countries: an example of a tropical agricultural economy that has prospered relatively well in the past on the policy of export specialization, but which has subsequently suffered from severe export fluctuations, an explosion of population, increased demand for food imports, limited land, and stagnation of real per capita product. What makes it unique is the concentration of so many problems in so confined an area and the fact that they can be quantified. The various parameters of the Mauritian economy have been extensively studied and numbers attached with an uncommon degree of precision.

The study is adapted from Dr. Vellin's Ph.D. dissertation and is one in a series of inquiries into the economics of agricultural diversification in low-income countries carried out under our direction. It is a pleasure to acknowledge the contribution of others. Miss Edith Adams and Mr. G. Naiken, of the Population Division of United Nations Headquarters, prepared the population projections. The maps and charts reflect the talent of Mr. Joe Baldwin. Mrs. Carol Sisler edited the original manuscript for publication.

T. T. P.

T. D. M.

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¹. Local measure of land, 1 arpent = 1.043 acres.

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MULTI-CRITERIA PLANNING FOR AGRICULTURAL DEVELOPMENT:

A FULL EMPLOYMENT STRATEGY FOR MAURITIUS

Many developing countries with export specialization in one or two primary products find further economic development difficult and have problems of fluctuations in export earnings and balance of payments. These are compounded by high unemployment rates and rapid growth of population. This research uses Mauritius as a case study to test the hypothesis that these problems can be ameliorated through an agricultural development strategy involving both import substitution and export diversification. The island has an easily quantifiable monocrop economy based on sugar and a severe unemployment and balance of payments problem.

A linear programming model is used to analyze simultaneously employment, foreign exchange and land utilization, and to test the feasibility of import substitution and export diversification. The model identifies different agricultural production, import, and export activities, and the objective is to maximize the agricultural balance of payments within land and labor constraints while maintaining a specified level of domestic consumption. Specifically, the population and unemployment situation are examined as they have evolved to the present day and the future dimensions of the problems are forecast. The consequences of the foreign exchange situation as determined by the exports of sugar and tea and imports of food are examined and the future prospects for Mauritius' international trade are explored. Empirical evidence that opportunities for import substitution and export diversification exist in the agricultural sector are presented by the analysis of the food consumption pattern, the sources of food supply, and a calculation of future food demand based on projections of population. The agricultural resource potential of the island is estimated in terms of the level of production and the scope for increase in production to create employment opportunities and improve the balance of trade.

The model uses data for 1968, high and low population projections, and improved production coefficients for 1975 and 1980. Five solutions of the model are compared with the current situation and are analyzed in the light of relevant criteria influencing their feasibility. Ways of implementing the solutions are discussed and agricultural policies needed to achieve an optimal degree of import substitution are formulated. The analysis and the results of the model show that it is theoretically possible to solve the problem of unemployment and balance of payments in Mauritius, that an agricultural development strategy based on import substitution and export diversification is possible, and that it is not incompatible with the maintenance of the traditional exports.

IMPORT SUBSTITUTION VS. EXPORT SPECIALIZATION

Export Earnings

The effects of fluctuations in export earnings from one or two products have affected adversely economic growth and economic welfare. The instability in export

earnings due to fluctuations in both commodity prices and level of domestic production is widely accepted. A comprehensive study by the International Monetary Fund indicated an average annual fluctuation in export earnings for primary commodities of nine percent for the period 1948-1958 with fluctuations rising much higher for some countries (26). The fluctuations for Mauritius are illustrated in Figure 1. These fluctuations are high relative to income. They result in variations in income affecting small farmers and business with consequent effects on employment and wages; government revenues, a substantial fraction of which are derived from taxes on foreign trade, incomes from export earnings; the country's capacity to import, which again affects development plans depending on imports of capital goods or industrial materials.

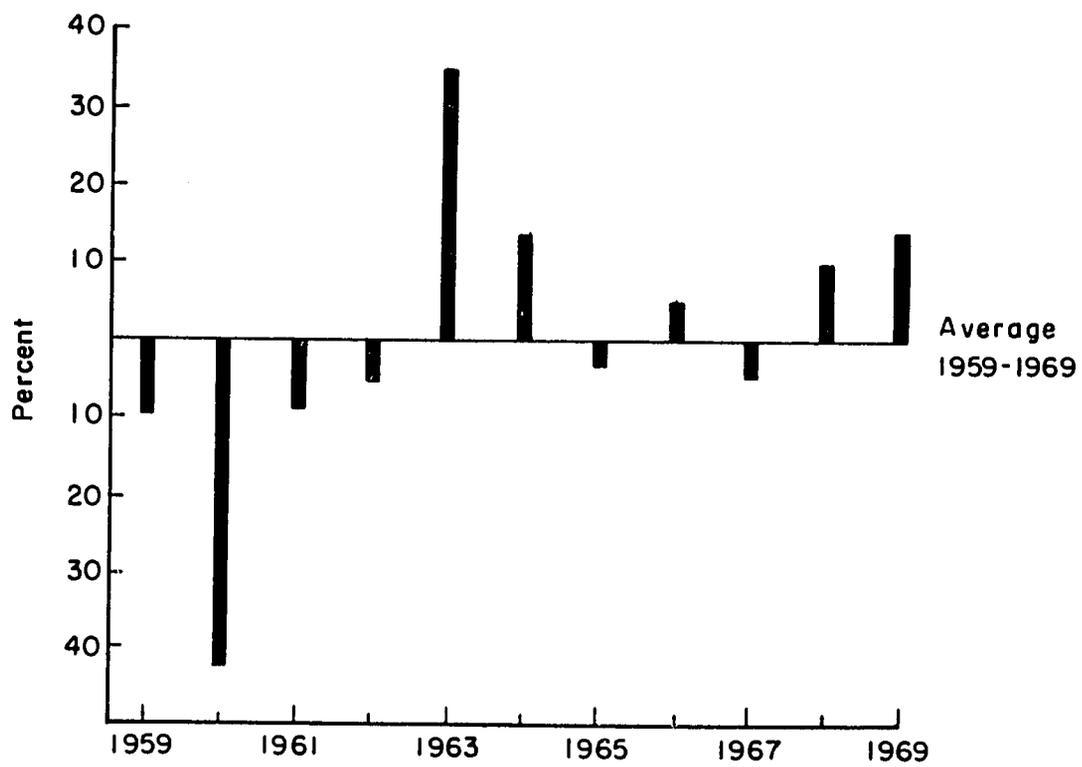
The population explosion due to a decided downward trend in mortality rates combined with a continuation of high birth rates has been instrumental in the change of strategy. It has prevented the gains from economic development from being translated into higher GNP per capita, causing widespread poverty and social unrest. Food production as a whole has failed to keep pace with the growth of population. This, combined with changes in food preferences, has increased the dependence on food imports and slowed the rate at which imports for development could be increased. The population of working age is growing at an annual rate of 2.3 percent and in the 1970's this will accelerate to 2.7 percent. This dramatic increase in the number of young people seeking some form of gainful employment is compounded by the widespread unemployment and underemployment that now prevails.

Import Substitution

Many developing countries have taken the position that comparative advantage theory has been robbed of its practical value because of import-export problems and is no longer relevant. They are adopting import substitution and agricultural diversification as the goal of their economic policy. Supporting arguments for an import substitution policy have been put forward by many economists. Industrialization on the basis of import substitution has been suggested as an important and effective counter to the deterioration of terms of trade (44). Import substitution based on domestic market size as indicated by imports has been considered as likely to lead to a pattern of industrial development accompanied by the establishment of forward and backward linkages (24). The most important explanation of growth and change in the relative importance of manufacturing output in the developing countries has been ascribed to import substitution on the basis of an analysis of cross country data (6). A public program to diversify the economy has been justified as appropriate only if there is some discrepancy between social and private costs due to uncertainty or if for some reason, private investors are unable to diversify adequately even in response to their own aversion to risk. Dependence on one or two primary products for export earnings has been proved to be the cause of such discrepancies (4).

The economic stability provided by a diversified agriculture has been considered of assistance to the process of planning for future development and to the creation of a favorable effect on the balance of payments. Contributions to employment in a labor surplus situation and to economic growth because of linkages with other sectors have been considered as justification for diversification even when risk discounted returns from the more diversified agriculture are less than those of the less diversified agriculture (43). Comparative advantage seems to have been almost buried, it being reasoned that the two are not compatible.

FIGURE I. MAURITIUS: PERCENTAGE FLUCTUATION OF EXPORT EARNINGS ABOUT AVERAGE 1959-1969



Based on data in Mauritius Central Statistical Office: Bi-Annual Digest of Statistics 1963-1969

Table 1. EXTENT TO WHICH EXPORT EARNINGS COVERED IMPORT EXPENDITURE 1960-1968 FOR SELECTED DEVELOPING COUNTRIES*

Countries in which, relative to the average ratio of exports to imports in 1960-1962, and 1965-1967, the ratio in 1968 was					
significantly above the earlier range		within the earlier range		significantly below the earlier range	
Country	Exports/ Imports 1968	Country	Exports/ Imports 1968	Country	Exports/ Imports 1968
Zambia	1.50	Guyana	0.93	Iran	1.36
Sierra Leone	1.05	Colombia	0.85	Ceylon	0.94
Ghana	1.00	Senegal	0.83	Dominican Republic	0.75
Pakistan	0.72	Kenya	0.55	Madagascar	0.68
India	0.70	Congo (Brazzaville)	0.52	Mauritius	0.60

* Data from United Nations, Department of Social and Economic Affairs, World Economic Survey, 1968, p. 107, United Nations, New York, 1970.

This alternative strategy has been criticized on the grounds that international trade if allowed to proceed freely can be expected to make as great a contribution in the future as it has in the past, while the price of diversification from concentration of exports is extremely high (21). Import substitution has also been accused of leading to problems of inefficiency and noncompetitiveness in those less developed countries adopting it (28).

Some economists suggest that comparative advantage still has a great deal in its favor, and that in fact export specialization may be pursued simultaneously with import substitution and may generate full employment, economic growth, and improved balance of trade. Taiwan is considered as one of the few countries which achieved import substitution while the agricultural exports provided the means of expansion in terms of savings and foreign exchange resources (42).

THE UNEMPLOYMENT SITUATION

The most pressing and real problem of Mauritius is unemployment. The post-war explosion in population and extremely slow increase in employment opportunities have made this problem almost endemic.

The human and social consequences have been masked only thinly by the growing number of children in attendance at school and by the extended family system which has acted as a form of "social security." The economic consequences have been more obvious, because the island has a wage economy. There is no subsistence

sector, and unemployment cannot be disguised as in an overpopulated peasant economy, where all may be employed and no one considers himself idle (41, p. 33). The ever-increasing redistribution of the country's total income in favor of those out of work heavily taxes the gainfully employed and may cripple their will to work.

Widespread unemployment and underemployment are inconsistent with economic development. Employment generation is as important as growth in per capita income. In Mauritius, although output per person employed has risen substantially in the last 15 years, the real per capita output of the population as a whole has remained stationary (36, p. 44). Redistribution of income cannot be maintained for much longer, and the extended family system also will not stand the strain indefinitely if the present rate of unemployment persists.

Population expansion has been thought a catalyst to economic growth (24, p. 176), if there is some room for expansion in the economy, and especially if it is endowed with a range of resources. However in Mauritius natural resources are scarce, and diversification into agricultural production other than sugar or into light industry has not taken place on a large scale. Consequently, the country may too closely approximate one investigator's characterization as one of those unfortunate cases of small island economies, "too densely populated to hope for further significant expansion of the primary exports and . . . too small to follow a massive industrialization policy suitable for larger countries" (39, p. 158). Despite expanded output, the per capita income from sugar in the '60's has stayed at a lower level than in the '50's, and employment opportunities in the industry have failed to keep abreast of population growth. The high specialization and export orientation of the industry has been partly responsible for the static labor situation.

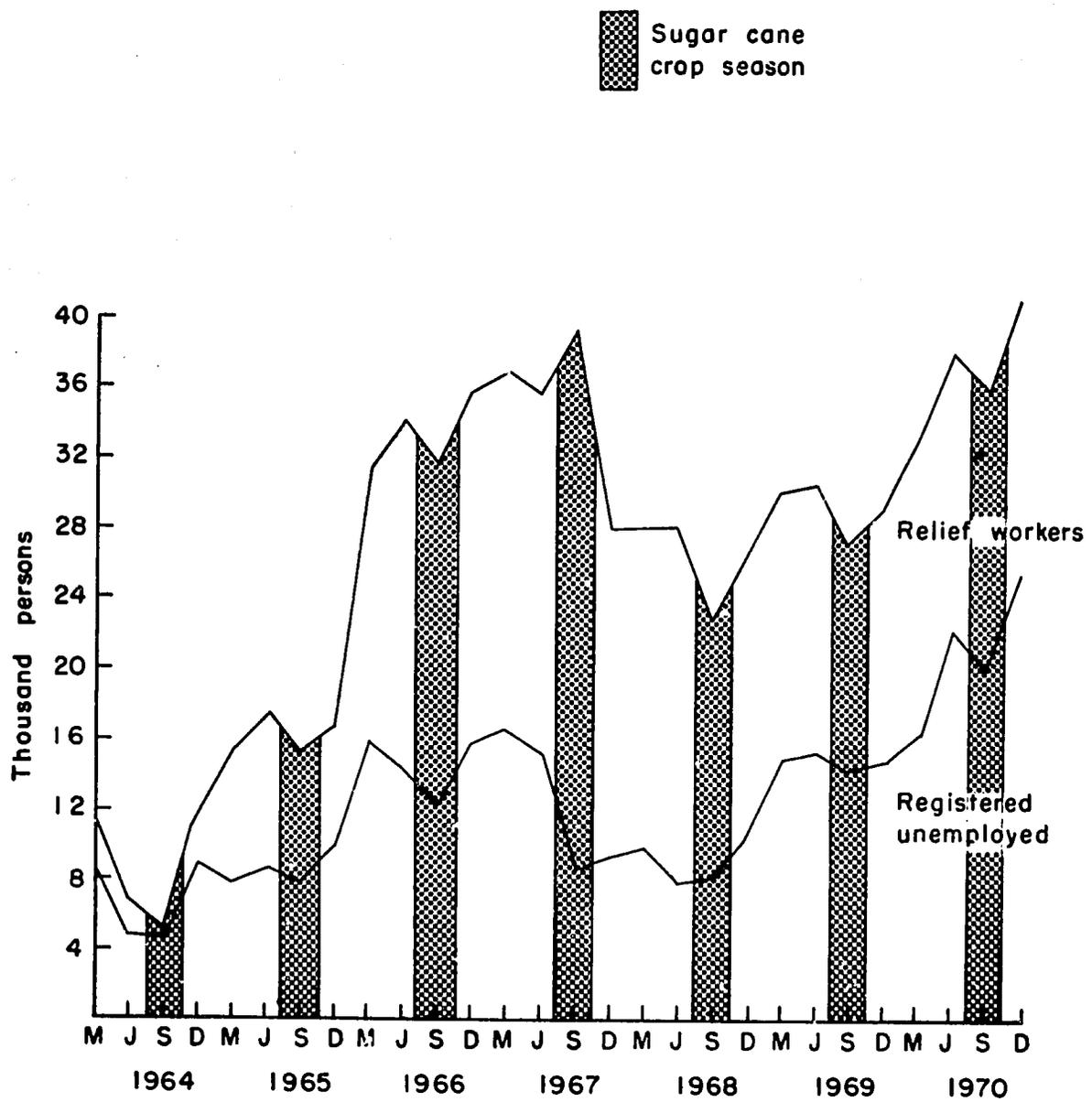
Rapid population growth has resulted in the very high population density of Mauritius. This overpopulation has emphasized the scarcity of land, Mauritius' least abundant resource. It has led to fragmentation of land holdings (such that the average size of small farmers' plots is only one-half acre) and to extensive use of land for housing. Although 47 percent of the population live in towns and urban areas, the low over-all housing density causes a severe loss of good agricultural land which can only be expected to grow as population density increases.

The Unemployed

Overpopulation has left in its wake a labor reserve of structurally unemployed persons. Government has tried for years to alleviate the unemployment situation by carrying out programs of public work specifically for providing relief work for some of the unemployed. The relief work program though socially desirable and politically imperative has been necessarily limited in scope by financial and organizational constraints. It has come under severe criticisms in the past years because of its unproductivity, unmanageability, and inflated ranks. There is a substantial demand for relief work although the wages are less than the minimum wages and work is for only three days a week.

The number of relief workers and registered unemployed has been increasing very rapidly as can be seen from Figure 2. The number of relief workers which was about 1,500 in 1964 rose to a peak of 32,000 in the election year of 1967 and decreased after

FIGURE 5. MAURITIUS : OFFICIAL INDICATORS OF UNEMPLOYMENT 1964 - 1970



Based on data in Mauritius Central Statistical Office: BI - Annual Digest of Statistics, 1965 and 1970

to an average of about 18,000. Budgetary constraints caused a further contraction in 1969, but at December 1970 the number of relief workers was 17,800. The number of registered unemployed which is exclusive of persons already employed and seeking a more congenial job has followed exactly the same pattern as that of the relief workers. The number decreases during the sugar cane crop season and unemployment level is at its lowest in September. There were 25,300 registered unemployed at December 1970.

These official statistics do not reveal the true extent of unemployment, as many persons are believed not to bother to register because of the futility of doing so. There is besides considerable underemployment in the services and in agriculture because of the seasonal nature of the main crops. There are large numbers of persons willing to work harder and longer to improve their lot, but are without the opportunity to do so. This is, however, difficult to measure.

Despite the difficulties of quantification, various estimates (5, 29, 35, and 49) have been made at different times of this labor reserve, and all underestimated its extent and growth. The first survey of employment, unemployment, and underemployment in 1958 found that 31,000 persons, or 15 percent of the economically active population were unemployed, i.e., not working but looking for a job (29). In 1962, the population census enumerated 11,000 persons as wage earners out of work and 9,000 males in the 15-24 age group as "not at school and never yet gainfully employed" (36, p. 26). The percentage of the whole population gainfully employed had decreased by six percent compared with 1952. The most recent estimate of unemployment in 1968, was 46,000 persons, slightly over 19 percent of the total labor force at the date (36, p. 18). This was about two-thirds higher than the total official number of registered unemployed and relief workers at that date. This official number has reached 43,000 at the end of 1970.

In view of the gravity of the unemployment problem, one must give priority to labor intensive activities in formulating policies for an agricultural development strategy.

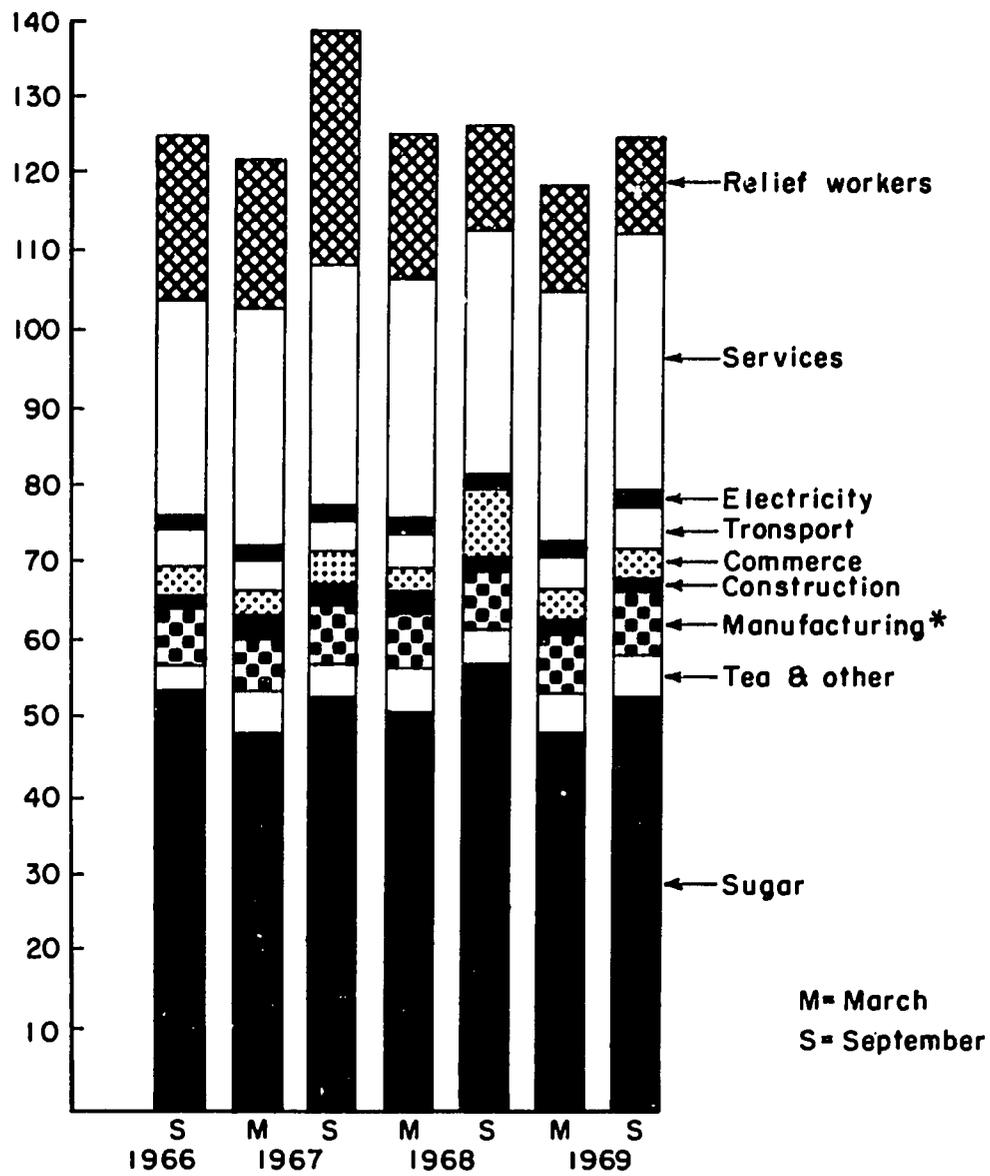
Present Employment

Agriculture

Employment in Mauritius is primarily in the agricultural sector, 39 percent of the gainfully occupied labor force at the 1962 census. The next in importance is the service sector, while the manufacturing sector has not shown much development yet. Between 1952 and 1962 the number of gainfully employed persons increased by only eight percent, or 1,300 per annum. The number of persons employed in agriculture decreased by eight percent while in the industrial sector the increase was 13 percent.

The present pattern of employment is known only for the large establishments, i.e., those employing more than 10 persons. The distribution of this labor force is illustrated in Figure 3 which shows a decrease in employment in the construction industry and slight increases in manufacturing and services. The employment pattern has a strong seasonal component due to the influence of the sugar industry on other sectors of the economy, for example storage and transport. Employment in the crop season is about 15 percent higher than in the intercrop season; this difference is mitigated by

FIGURE 6. MAURITIUS: EMPLOYMENT IN LARGE ESTABLISHMENTS BY SECTORS, 1966-1969



* Excludes employees in sugar and tea factories

Based on data in Mauritius Central Statistics Office, Bi-Annual Digest of Statistics, 1953-1969

legislation on security of employment compelling large employers to keep year-round those employees who have worked for a percentage of the crop season.

The probable labor force in agriculture in 1968 was estimated by using 1962 census data on agriculture and the estimated increase in employment in the non-agricultural sector. This estimate summarized in Table 2 was checked by comparison with 1968 employment statistics in large agricultural establishments and estimates of labor employed on small farms. Complications arise in gauging the agricultural labor force due to the great amount of duplication that exists.

Table 2. ESTIMATES OF LABOR AVAILABLE FOR AGRICULTURAL SECTOR, 1968

	Number of Persons Employed <u>(thousands)</u>
Large Establishments: ^{1/}	
Estates with Large Factories	46.4
Large Planters (greater than 25 arpents)	10.9
Tea (greater than 5 arpents)	3.1
Other (tobacco, aloe, etc.)	1.2
Small Scale Agriculture:	
Small Planters and Metayers	28.9 ^{2/}
Relief Workers and Unemployed	21.9 ^{1/}
TOTAL Available for Agricultural Sector	112.4
Rough Check:	
Total Economically Active Population, 1968	234.4
Non-agricultural Sector: Economically Active Population at Work in 1962 ^{3/}	109.3
New Jobs Created Since 1962, Non-agricultural: (2000/yr.)	12.0
Total Employed in Non-agricultural Sector	121.3
Manpower Available for Agricultural Sector	113.1

1. Mauritius Central Statistical Office, Digest of Statistics, 1968.
2. Mauritius Chamber of Agriculture, President's Report 1968/69.
3. Central Statistical Office, 1962 Population Census of Mauritius and its Dependencies, Vol. 1, p. 24.

The size of holdings, the kinds of crops and the methods of cultivation combine to determine the degree of labor utilization. Many of the small land owners produce more than one crop, and also engage in varied activities; only 700 of them were estimated to be growing food crops only as a full time activity in 1967 (36, p. 84). Planters of tea in many cases have other sources of income (23, p. 10), and like tobacco producers and food crop growers, generally plant sugar cane. Agricultural self-employment may also be considered a subsidiary or part-time activity, since most small planters (harvesting less than 5 arpents) hire their services to large planters

and estates or have jobs outside agriculture. This was confirmed by the results of an agro-socioeconomic survey of 150 small farmers, which the author carried out in 1968 for the Ministry of Agriculture.

Livestock production is another part-time activity (18,000 producers own fewer than 3 head of cattle each), and there is a large number of unremunerated females and children who collect fodder. The estimate of the labor force available for the agricultural sector in 1968 is 113,000. The estimate does not imply that these persons were all agricultural workers, or that given the choice, they would choose agricultural employment. With the estimated unemployed numbering 46,000, the employment in agriculture may therefore be estimated at 67,000. This would imply that the number of persons gainfully employed in agriculture has remained stationary since 1962, when this figure was 67,000. This stagnation in agricultural employment in the '60's, as well as the eight percent decrease between 1952 and 1962 may be considered as normal in economic development. However, in Mauritius the implications are very severe since there are few alternative jobs for the displaced workers.

Industry

Since 1963 there has been a burst of industrial activity, more than 50 new industrial firms have begun operation in Mauritius, most of them after 1965. This has increased the labor force in industrial establishments employing more than 10 persons (excluding sugar and tea factories) by only 10 percent between 1966 and 1969. A survey of all manufacturing industries in 1967-68 estimated that the 3,700 firms employed about 20,000 persons (46, pp. 11-12). If this is compared with the 26,000 enumerated in 1962 in manufacturing, it shows how small the impact of recent industrialization has been on employment creation.

Industrialization has had some "backwash" effects on employment, affecting adversely the incomes and security of large numbers of artisans such as shoe makers, cabinet makers, etc. This occurrence is not unique: in Puerto Rico the total labor force decreased by 35,000 and employment by 12,000 between 1950 and 1962 while manufacturing employment rose by 65 percent with a corresponding growth of output of over 300 percent, while the GNP increased at 5.2 percent per year (47). Puerto Rico, however, had emigration to the U.S. as a safety valve, but from Mauritius emigration possibilities are very limited.

The only employment sector that has increased appreciably is the tertiary sector, especially services (see Figure 3). The increases in the service sector have taken place in both the government and the public sector. The ranks of the former have been swollen by the relief workers who are largely unproductive. Employment in the newborn tourist industry has started to increase rapidly.

Productivity

The unemployment problem is made worse by the fact that the labor market is saturated; underemployment and low productivity per man exist in all sectors of the economy because of the persistent oversupply of labor. The social pressure exerted by those seeking employment is difficult to resist in such a small island, and "even

the most convinced marginalist" of the entrepreneurs has to yield to it and hire more people than he should according to his own rule (20). Trying to increase productivity per worker by reducing the number of workers would increase the hardship. Three sugar factories could probably handle all the sugar cane of the island instead of the 22 presently operating, and bulk handling of sugar would eliminate the inefficient and wasteful use of bags. These changes would lead to hundreds of factory workers and thousands of dockers becoming redundant, besides the repercussions on the employment in the fibre industry producing the bags.

More employment opportunities may possibly be created as a consequence of future population increase which determines to a large extent the higher level of food requirements of the island. Under conditions of scarce foreign exchange the increased food needs would probably have to be produced locally, thereby creating more employment opportunities in agriculture. The determination of the future size of the population is therefore an essential element in the planning of an agricultural development strategy.

The Demographic Future

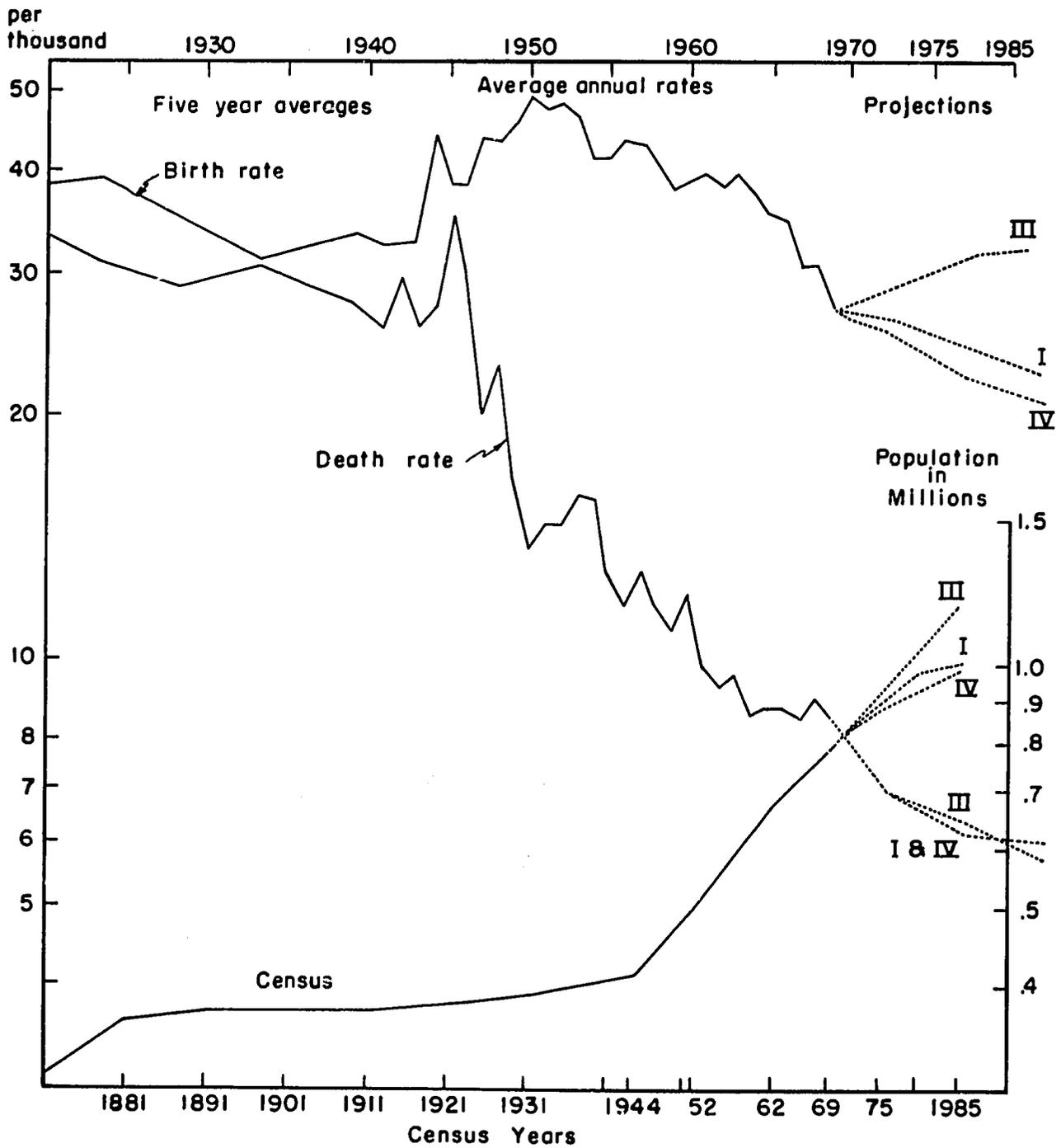
The current employment situation results from the demand for labor remaining practically stable while the ranks of the labor force were increasing. In 1950, after the eradication of malaria, the birth rate rose to nearly 50 per thousand in 1950, while the death rate dropped to 14. The country's cumulative rate of population increase, which averaged about 3 percent per annum during the '50's and early '60's, was one of the highest in the world. This rapid expansion is illustrated in Figure 4; between 1949 and 1963 the island's population grew by over two-thirds, from 419,000 to 713,000.

Since 1963 this trend has reversed itself completely, and the birth rate fell from 40.3 in that year to 27 in 1969, a decline of 33 percent over the 6 year period. The mortality rate has diminished more slowly, and is already lower than in many of the highly developed countries. Although the rate of population increase has decreased dramatically since 1963, the population of the island stood at 810,000 in 1970.

New population projections seemed warranted because of the recent trends in fertility and the appearance of emigration as a significant factor in slower population growth (emigration had not even been considered in earlier projections). These two ingredients, as well as mortality rate, were assumed as parameters underlying the 4 projections prepared by Miss E. Adams, a United Nations demographer, for this study. The birth rates, death rates, and rates of natural increase implied in the population projections are summarized in Table 3.

The continuing decline of the crude birth rate in Mauritius has been noted previously, and this has been associated with 37 percent decrease in the island's gross reproduction rate (from three to 1.9) between 1963 and 1969. Comparisons were made with Singapore, Ryuku Islands, Trinidad and Tobago, Taiwan, and Japan, countries which experienced similar rates of decline when their gross reproduction rate was about three. Based on these figures, it would not be unreasonable to assume a decline of 25 percent in the gross reproduction rate in the years 1968-73, one of 20 percent during 1973-78, and of 15 percent in the years 1978-82, to a final value of about 1.3.

FIGURE 7. MAURITIUS: BIRTH RATES, DEATH RATES AND POPULATION TRENDS



- I Medium Fertility, No Emigration
- II Constant Fertility, No Emigration
- IV Low Fertility, Emigration

Based on data from Central Statistical Office, Bi-Annual Digests of Statistics
 Projections by Adams, E. prepared for this study

Table 3. BIRTH RATES, DEATH RATES AND RATES OF NATURAL INCREASE IMPLIED IN POPULATION PROJECTIONS FOR MAURITIUS*
(per 1,000 population)

Projection	Crude Birth Rate	Crude Death Rate	Rate of Natural Increase
I (MEDIUM)			
without emigration)			
1970-75	26.3	7.0	19.3
1975-80	24.4	6.3	18.1
1980-85	22.5	5.9	16.6
II (MEDIUM)			
with emigration)			
1970-75	26.2	7.0	19.2
1975-80	24.4	6.4	18.0
1980-85	22.5	6.0	16.5
III (HIGH)			
1970-75	28.9	7.0	21.9
1975-80	31.5	6.4	25.1
1980-85	32.3	5.8	26.5
IV (LOW)			
1970-75	25.5	7.0	18.5
1975-80	22.4	6.3	16.1
1980-85	20.8	6.0	14.8

* Prepared by Edith Adams for this study.

Decline in Birth Rate

Several factors are responsible for the decline in crude birth rate and gross reproduction rate, and qualitatively support the assumption of a continued downward trend. A most important factor has been public acceptance of contraception and family planning. Although the effect of the Family Planning Campaign cannot be quantified at this stage, the results of propaganda, information and education seem to have been felt. Statistics of the Mauritius Family Planning Association show that almost 40,000 women, i.e., about 35 percent of all women in the reproduction age, have accepted the use of contraceptives. A notable success of the Family Planning Association and "Action Familiale" is their increasing appeal to younger recently married women. Both associations receive a yearly grant from the government and have increased foreign assistance. The family planning campaign probably owes its success in the island to the relatively high degree of literacy, and the well organized medical service, which serves a high density of population in a small island.

Abortion is illegal in Mauritius except on specified health grounds, yet its incidence seems to have increased. The number of cases with complications following abortion admitted to hospitals has increased from 774 cases in 1959 to 2,837 cases in 1969 (54).

Another factor behind the lower birth rate is the postponement of marriage to a later age. Delay may be attributed jointly to the increased secondary school attendance of Indo-Mauritian girls (whose enrollment has grown 150 percent between 1962 and 1969), and to the high unemployment rate among youths. Thus, there has been a drop in the age specific marriage rate between 1962-66 and 1967-69 from 16.6 to 15.3 and from 28.7 to 26.3 (per thousand) for the 15-19 and 20-24 age groups. Findings of a fertility survey conducted early in 1970 by the Population Control Evaluation Program further showed that average age at the start of a union had gone from 17.5 for the period 1952-62 up to 18.5 years for 1962-69 (54).

Decline in Death Rate

The death rate is low, and the survival rate to adulthood of those children born is high. Children do not represent a source of income, but are rather a liability, as there is high unemployment among youths. These factors provide a concrete motivation for having smaller families, such motivation surmounts the barrier represented by the technical limitations and liabilities of the methods employed for family planning.

The old notion that birth rates automatically fall as economic conditions improve is apparently only half of the real situation. In Mauritius, the deterioration of economic conditions, lower per capita national income and high unemployment have helped to lower the birth rate by stimulating more ready acceptance of family planning education and postponement of marriage.

Mortality projections were based on a moderately increasing life expectancy, since the nation seems to correspond already to the "rapid mortality decline model" of the UN (1, p. 13). Because of the rather high figure to which the life expectancy has now risen (58.6 years for males and 61.9 years for females), it seems likely that future gains will proceed at a slower pace. The projections assumed that an increase of about half a year in life expectancy would occur each year throughout the projection period¹, and average life expectancy at birth for males will thus rise to about 68 years in 1982-87 (1, p. 47).

Emigration

An annual emigration of 3,000 has been assumed for population projections II and IV, based on recent emigration trends; the emigration rate averaged 0.3 percent of total population annually for 1964-66, comparable with that of certain South European countries which experience substantial emigration. Emigration was for this reason considered to affect population estimates tangibly. The assumptions about emigration

1. A little less during the latter part of the projection when very low mortality has been reached at certain ages.

have used the average age-sex pattern of the emigrants for the 1961-68 period, because it is likely that the structure of the age-sex pattern of the 1965-68 emigrants may have been exaggerated by the sizeable proportion of economically and socially well-to-do families who emigrated out of dislike or fear of the political and ethnic atmosphere surrounding the achievement of independence by Mauritius. This type of emigration has decreased and will continue to decrease as ethnic harmony and political stability grow (40).

There have been discussions with other governments concerning emigration possibilities, some of which seem attractive; for example, it may be possible for some 2,500 young persons annually to go as student nurses to Germany and be employed after their training. Provision was made in the 1969-70 government budget to help finance the fares of would-be migrants.

The final results of the population projections are summarized in Table 4 for 1975, 1980, and 1985. These population projections are used subsequently to determine the labor force and the consumption constraints in the model used to test the feasibility of import substitution and export diversification.

Table 4. PROJECTIONS OF POPULATION OF MAURITIUS, 1970-1985*

Projections	Assumptions	Base and Projected Population '000			
		1970	1975	1980	1985
I	Medium Fertility, Declining Mortality, No Emigration	810.8	893.1	978.0	1,062.7
II	Medium Fertility, Declining Mortality, Emigration	810.8	877.1	944.0	1,009.6
III	Constant Fertility, Declining Mortality, No Emigration	810.8	904.8	1,025.9	1,171.3
IV	Low Fertility, Declining Mortality, Emigration	810.8	874.0	931.4	987.3

* Prepared by Edith Adams for this study.

Prospects for Employment

The further unemployment can be affected by population control only in the long run, while emigration has a more immediate effect. The size of the work force in the next decade is already determined by the present population. The country is being faced with a dramatic increase in the number of young people seeking gainful employment. Population control would have no direct effect on unemployment, but would help to ease

the economic pressure on the poorer families and give more scope to the extended family system cushioning unemployment. It would also enable government to save on social services and invest in public sector development. Most important of all, the lowering of birth rates would create a favorable climate necessary to attract investments, both local and foreign, to spur economic development needed to create employment opportunities.

The population bulge resulting from the demographic explosion is responsible for the future impact on the labor force. The effect of possible emigration is taken into account in the low projections illustrated. The number of economically active persons are those 15 to 64 years of age, gainfully employed and those willing to work but unemployed. This amounted to 243,000 in 1970 and will increase to at least 278,000 in 1975 and 318,000 by 1980. These projections assume the activity rates as at 1962 census, which were very low, averaging 86.3 percent for males and 19.3 percent for females. The economically active populations as projected for 1975 and 1980 are summarized below in thousands.

	<u>1970</u>	<u>1975</u>		<u>1980</u>	
		Low	High	Low	High
Total population	811	874	905	931	1,026
Economically active males	202	231	236	265	275
Economically active females	41	47	48	54	56
Total economically active	243	278	284	318	331

The problem of employment is not confined solely to the absorption of the growing number of young people. It is compounded by the widespread employment and unemployment already existing.

These projections imply that if the number of unemployed is to remain at the present absolute level of about 46,000, some 35,000 new jobs have to be created by 1975 and about 75,000 by 1980 to keep pace with population growth of the lower projections. This is if emigration is assumed, but if there is no emigration the number of new jobs would have to be increased by another 17 percent.

If the number of employment opportunities increases by 3,000 a year and present labor productivity is maintained, the unemployment would still rise to 21 percent of the economically active population by 1975. The number of economically active women wanting to work will most probably increase as a result of a higher level of schooling and higher age at marriage, and if the labor productivity rises, the required number of jobs that will have to be created would have to be raised further still. These unemployment statistics are depressing, and indicate the magnitude of the social, political, and economic problems the island will have to face.

Unemployment in Mauritius occurs at all levels of skill and education, even for those with good academic and other qualifications; this unemployment of qualified school and university graduates is a potential source of social tension and political instability (13). A growing number of discontented youths feel cheated of the jobs to which they think education has entitled them. Racial and social tensions have been

exacerbated by the pressures of population expansion and unemployment and have in turn magnified economic difficulties. The current state of affairs is explosive, and violence and destruction of property threaten the island if some way is not found soon to develop work opportunities and in this way relieve poverty.

THE FOREIGN EXCHANGE SITUATION

Export Orientation of the Economy

The export-oriented economy of Mauritius is an exceptionally "open" one. Most of its income is derived from exports which represent 40 percent of the gross national product, and production for exports has expanded more rapidly than other sectors of production in the past decade.

Sugar and molasses account for more than 95 percent of the export trade of Mauritius (Table 5), indicating the high dependency on one crop, sugar cane. The second crop in importance is tea, which only amounts to 4 percent of the export trade. While tea is still a minimal contributor to revenue, the money value of its exports has increased by 2.5 times in the last 5 years. The industrial exports, i.e., manufactured goods, machinery and transport equipment, which were negligible, have increased significantly from 720,000 rupees in 1968 to 2.5 million rupees in 1969, as a result of recent industrial development, but there has been no concurrently significant diversification of agricultural exports.

The Need to Import

A consequence of Mauritius' export-oriented economy is its high propensity and need to import; import expenditures are equivalent to more than 46 percent of the island's gross national product. Imports of machinery, manufactured goods, transport equipment and minerals comprise one-fifth of the import bill and come primarily from the United Kingdom. In food imports, Thailand from which Mauritius buys rice has replaced Burma as the most important supplier. The main wheat sources are France and Australia. Mauritian edible oil supplies come from a large number of countries; West Germany was the major supplier of more than two-thirds of imported needs in 1968, while a year later the U.S.S.R., Yugoslavia and Spain had become major suppliers. Other important food suppliers are the Republic of South Africa for fruits, Australia for meat and dairy products, and Madagascar for live cattle.

The level of exports is the most influential factor affecting aggregate demand, especially of imported foods, on which expenditures rise after a good sugar year. Expenditure on food adds substantially to the import bill, but the level of investment expenditures also depends primarily upon imports of capital goods. It is therefore difficult to use monetary measures to expand the economy, as the multiplier effects of investment and benefits from increased incomes are dissipated through imports.

Table 5. DOMESTIC EXPORTS OF PRINCIPAL COMMODITIES,
MAURITIUS, 1961-1969*
(Rs. million f.o.b.)

Commodities	1961	1962	1963	1964	1965	1966	1967	1968	1969
Sugar	272.2	282.0	400.2	344.2	290.3	306.4	281.3	320.7	326.0
Molasses	5.0	9.1	13.5	8.8	5.0	11.5	8.5	111.9	10.1
Tea	4.9	3.9	5.5	4.4	5.9	6.5	8.4	9.6	14.6
Other	1.6	2.1	1.8	2.5	2.2	4.1	2.4	4.0	7.6
TOTAL Domestic Exports ^{1/}	283.7	297.1	420.9	359.9	303.5	328.6	300.7	346.3	358.2
Re-exports	10.5	8.8	6.8	7.0	9.9	9.0	6.1	7.7	7.0
TOTAL Exports	294.2	305.9	427.8	366.9	313.4	337.6	306.8	354.0	365.2
Sugar and Molasses as a Percentage of Domestic Exports	95.2	95.8	96.8	96.2	95.1	96.7	96.4	96.0	92.3

* Data from Mauritius Central Statistical Office, *Digest of Statistics*, 1965 to 1969.
1. Including the value of sugar quota certificates and bonuses received in lieu of Commonwealth preference.

Even the revenue government needs to meet its ever increasing recurrent expenditures depends to a large extent on the value of sugar exports. Fluctuations in the latter have affected considerably the level of public savings in the last few years, depleting the revenue reserves. A grant in aid of administration from the United Kingdom Government of 17.3 million rupees was needed in 1967-68. Development financing has resulted in increasing government indebtedness which has more than trebled in the last 10 years. The gross annual public debt obligations have grown proportionally; interest, repayments and payments into the sinking fund totalled more than 13 percent of the current revenue in 1969-70. Such external obligations increase the balance of payments problem, which will deteriorate further if the total value of exports does not increase, or if there is not a decrease in the value of imports. Austerity measures such as increases in customs duties, higher taxes, and reduction in government expenditure, together with felicitous rises in the world price of sugar and in tea exports, have helped to produce a favorable balance of payments in 1969.

Balance of Trade

The balance of payments was not a critical problem for Mauritius when it was in the "sterling exchange." Its currency was linked with the pound sterling before independence, the monetary system was centered on London, and the currency was in sterling securities. Under this monetary system the balance of payments deficits were self-correcting because the domestic supply of money was dependent on the assets in sterling and declined with it. Even though the balance of payments vis-a-vis the United Kingdom has always been favorable, the Mauritian government's level of activities still depended to a large extent on the fluctuating level of exports, and it was hampered by the inability to finance its operations through credit creation.

Since 1958, a decade prior to independence, the value of imports has increased steadily as population increased, resulting in an almost continuous balance of trade deficit. Figure 5 illustrates the trend toward visible trade deficits in the period 1953 to 1969. The value of exports has been very erratic due to the previously mentioned vagaries of sugar trade. Cyclones halved exports in 1960, while a record crop and high world prices caused by the U.S.-Cuba break brought the exports to a peak in 1963. The closure of the Suez Canal in 1967 favorably affected the balance of visible trade with lucrative re-exports of bunker fuel and ship's stores. The ships have also provided a ready market for local produce such as vegetables, fruits, and eggs. Thus, sales value of bunker fuel and ship's supplies has increased 4 times between 1966 and 1969.

Deterioration of Trade

The visible trade deficits are accentuated by the steady deterioration of the terms of trade. The volume of exports increased by seven points and that of imports decreased by 12 points comparing 1964 and 1968. But, the price index of exports decreased by 10 (sugar prices fell to extremely low levels), while that of imports of machinery, chemicals and equipment increased by 23 in the same period. The net result is that there has been a worsening in the terms of trade for Mauritius, which had by 1968 reached 26 points below the 1964 level (see Figure 6). The balance of goods, services and current transfers has been negative during each of the last ten years, except for the unusual year of 1963.

The deficit in visible trade is compounded by the deficit in the invisible transactions. Expenditure by tourists to Mauritius is expanding, and the number of tourists has doubled between 1966 and 1970, but this promising industry is still in its infancy.

The foreign exchange situation of the island depends to a large extent on the health of the world sugar economy, and can best be understood by studying the Mauritian sugar industry in its international setting. Sugar is the world's most politically influenced commodity, and Mauritius will have to use whatever small political influence it has to improve its share of the protected markets.

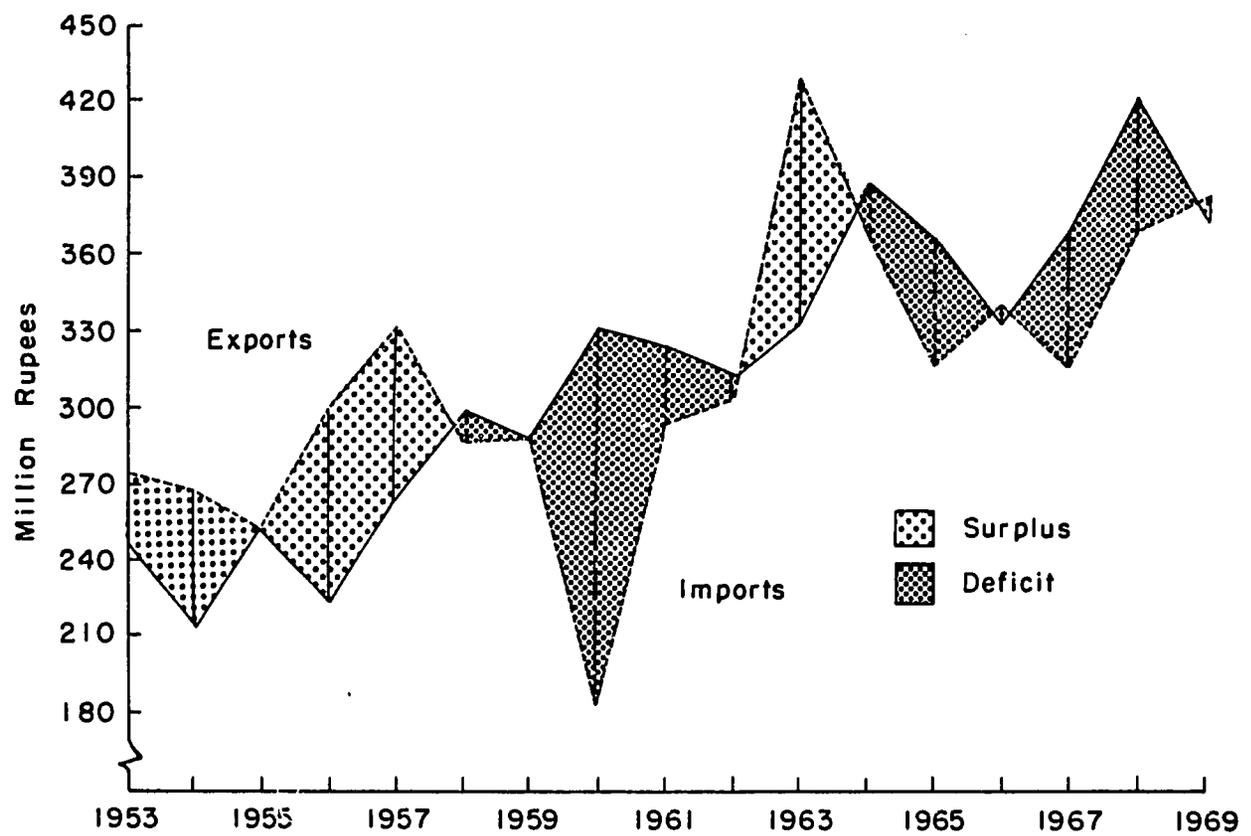
Mauritius and the World Sugar Economy

The world sugar economy and trade may be traced back to historical events and relationships. Mauritius was one of the sugar islands added to the British Empire as a result of the French and British rivalry for the monopoly of the sugar trade in Napoleonic times.

The recent history of the world sugar industry can be discussed against the background of Figures 7 and 8. World War I affected beet sugar production in Europe, disrupting international trade.

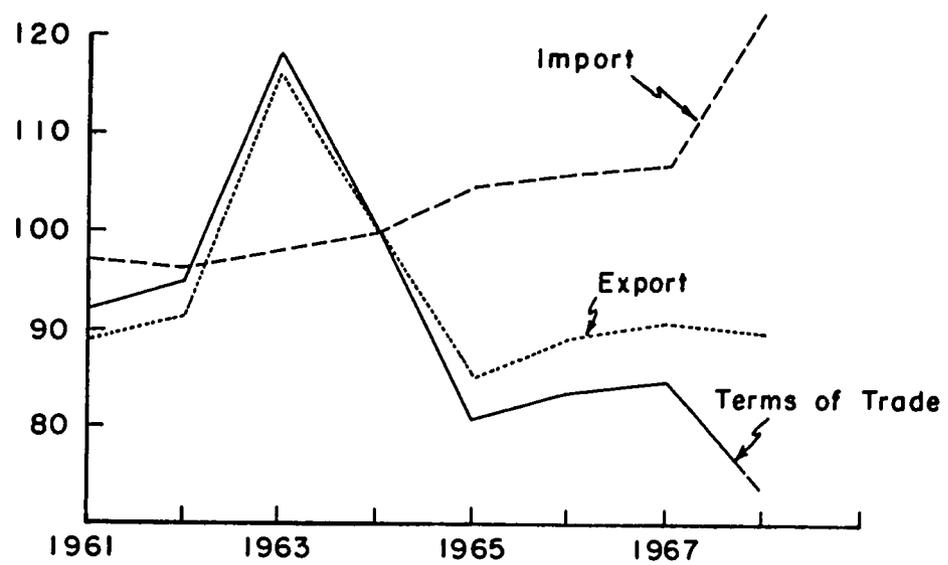
The great depression of the 1930's affected the world sugar industry considerably. Many plantations went bankrupt in the sugar islands. In Mauritius some sugar estates in the less favored areas sold out to their laborers. Thus started the small planters group of sugar producers. Market speculations depressed sugar prices, and sugar consumption fell due to decreased purchasing power. Production fell by more than 26 percent between 1930 and 1932.

FIGURE 10. MAURITIUS: BALANCE OF VISIBLE TRADE 1953-1969



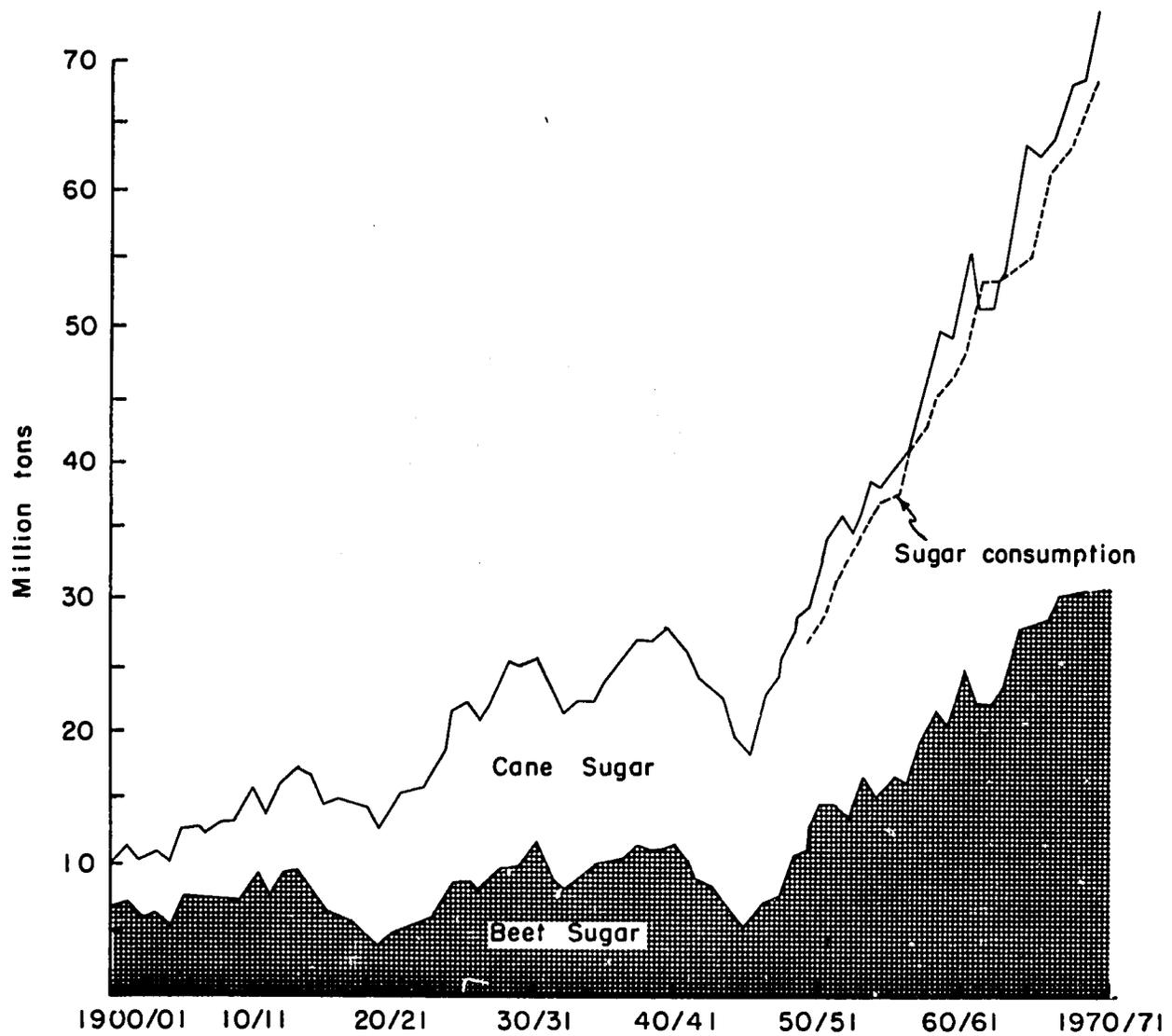
Based on data in Mauritius Central Statistics Office, Bi-Annual Digest of Statistics, 1953 - 1969

FIGURE II. MAURITIUS: PRICE INDICES OF EXPORTS, IMPORTS AND TERMS OF TRADE (1964 = 100)



Based on data in Mauritius Central Statistical Office : Bi-Annual Digest of Statistics 1969

FIGURE 12. WORLD SUGAR PRODUCTION 1900/01 - 1969/70*
 WORLD SUGAR CONSUMPTION 1949 - 1969**

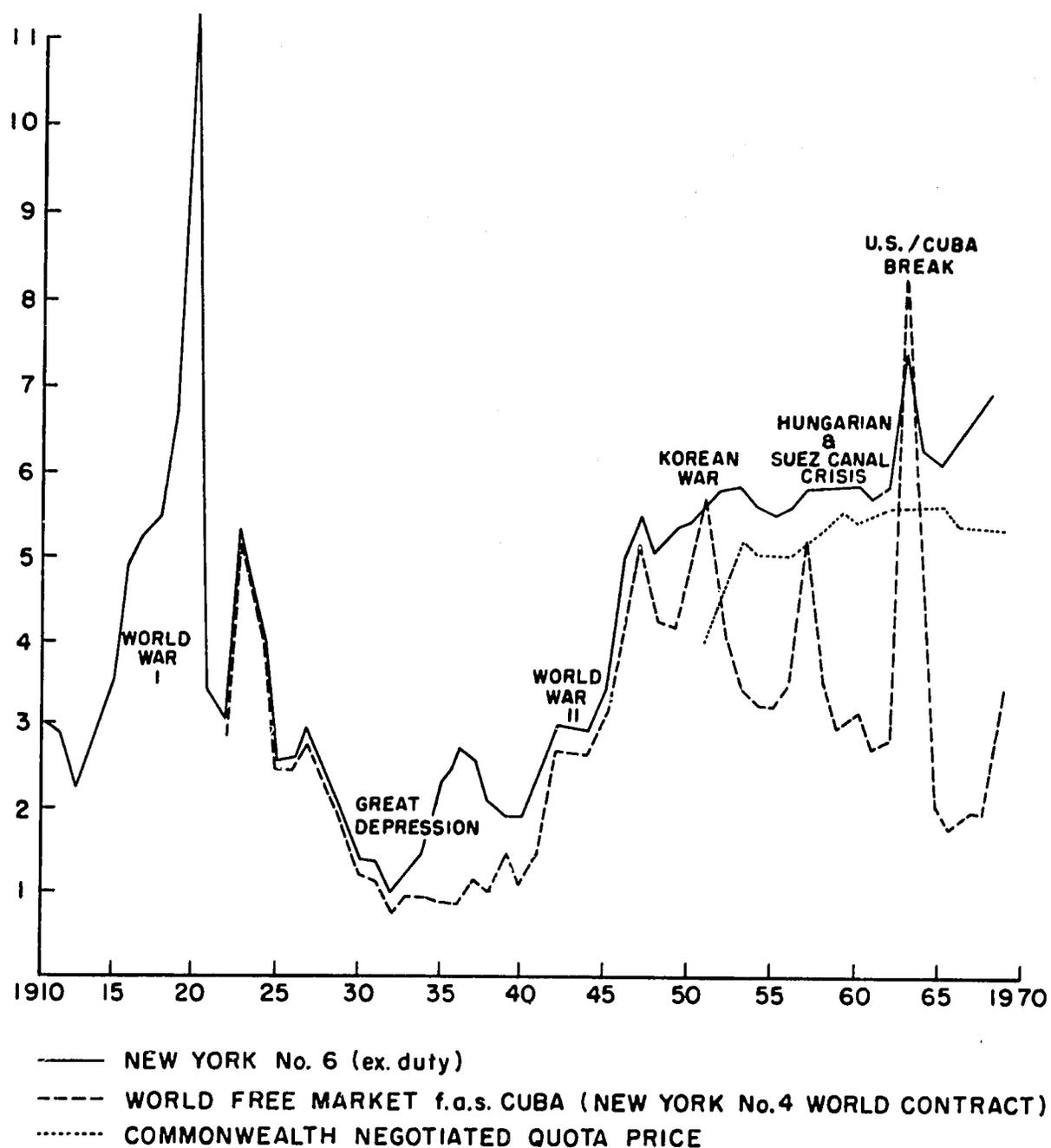


* Crop Year

** Calendar Year

Source : Int. Sugar Council : The World Sugar Economy Vol. I
 The World Picture, London, 1963
 Int. Sugar Council, Sugar Year Book, 1966-69
 Int. Sugar Journal, April, 1970

FIGURE 13. WORLD SUGAR PRICES, 1910-1969. (U.S. CENTS PER POUND)



Based on data from FAO, *The World Sugar Economy in Figures, 1880-1959*,
 Commodity Reference Series, Rome, 1962
 International Sugar Council, *Year Book 1969*, London, 1969

World War II caused a big decrease in both beet and cane sugar production. The beet sugar production in Europe and cane sugar production of Asia were seriously affected. Production in the rest of the world remained more or less static while Central America's output increased slightly. The post-war period saw a great increase in production of sugar, in most cases exceeding the pre-war level.

The last major political event influencing the course of sugar history has been the U.S.-Cuba crisis. The break between the U.S. and Cuba caused a change in the direction of trade of Cuban sugar which represented 50 percent of the U.S. quota. The decrease in Cuban sugar production coupled with a bad crop in Europe sent the price of sugar rocketing to an unprecedented peak in 1963 and caused another boost to production. The U.S. sugar quota distributed the regional influence of the production increase which was felt even in Mauritius. The island had her first U.S. quota in 1962, and her most prosperous sugar year followed in 1963 when 10 percent of the record crop was sold to the U.S.

Current trends suggest a continuation of abundant sugar supplies on the market; world production has been increasing and reached a record 73 million tons in 1969-70. Consumption has also increased steadily, and has reached a peak of 72 million tons.

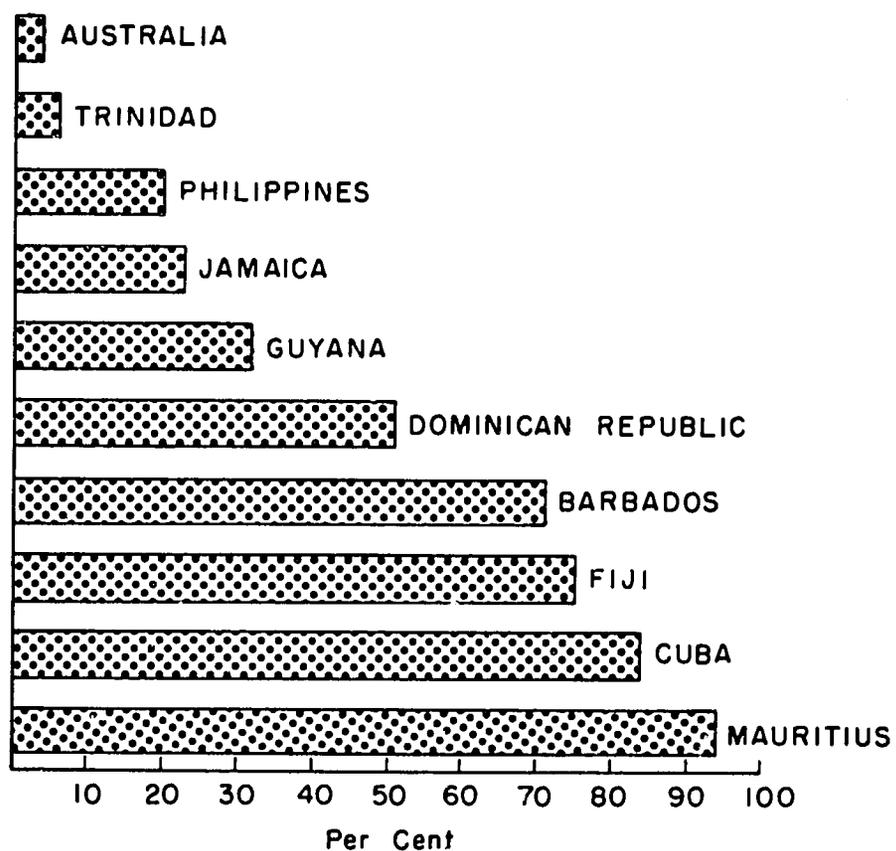
Thus, although sugar acreage has expanded in most countries and world production has more than doubled in the last 30 years, world trade in sugar has decreased. Export trade expressed as a percentage of total production has been constantly, although gradually, diminishing since the 1920's when exports represented 70 percent of total production; they make up now only 34 percent of the total sugar production. The decrease in the export trade has not been met by any decrease in production of the main sugar exporters, which have rather been expanding output. For those countries like Mauritius, Cuba, Barbados, and Fiji whose main revenue derives from sugar trade and who are extremely dependent upon it (see Figure 9), it is becoming increasingly difficult to find markets for their produce.

The drive for self-sufficiency by numerous small countries has operated against international sugar commerce, and hence to the disadvantage of Mauritius. However, sugar production, like that of oil seeds, tobacco and rice, is also carried on by the high income countries of Northwest Europe and North America, which are at the same time the most important consumers. Increased domestic production by these "developed" consumer countries constitutes the principal obstacle to expansion of sugar exports.

Mauritius in the Political Arena of the Sugar Trade

The fate of sugar on which countries like Mauritius depend is determined by international as well as internal politics of the industrialized developed countries. Perhaps the most telling indication of the extent to which the world sugar economy is dominated by politics is the fact that 85-90 percent of the world's supply of centrifugal sugar production receives some sort of protection; world sugar trade is characterized by special marketing arrangements and preferences. The bulk of commercial movements are between overseas territories and their mother countries, for example, between the United Kingdom and the Commonwealth countries, the offshore areas and the

FIGURE 15 RELATIVE VALUE OF SUGAR EXPORTS TO TOTAL EXPORTS (AVERAGE 1962-1968)



Based on data in Commonwealth Secretariat: Plantation Crops, London, 1970, p. 108

United States, Cuba and the Sino-Soviet group, Portugal and her overseas territories, France and her former colonies, the centrally planned countries of Eastern Europe and the U.S.S.R., and the U.S. and its quota holders. That small part of the sugar which is not protected is sold on the "free market," which currently handles about one-fourth of Mauritian sugar production.

The so-called "free market" for sugar has been defined by various authors as: residual quantities of sugar sold internationally (29, p. 211); as that portion of total import requirements not reserved for particular categories of supply and where import duties and export restrictions prevail (51, p. 23); and also as that residual which sellers could not dispose of on more favorable terms. In this paper, "free market" excludes all exports which move under preferential arrangements, it excludes imports received by the U.S.S.R. from centrally planned countries and Cuba, trade within the French Community, Portuguese Community, the U.S. and its quota holders, and Commonwealth sugar trade. The main importers on the "free market" are Japan and the U.K.

The "Free Market"

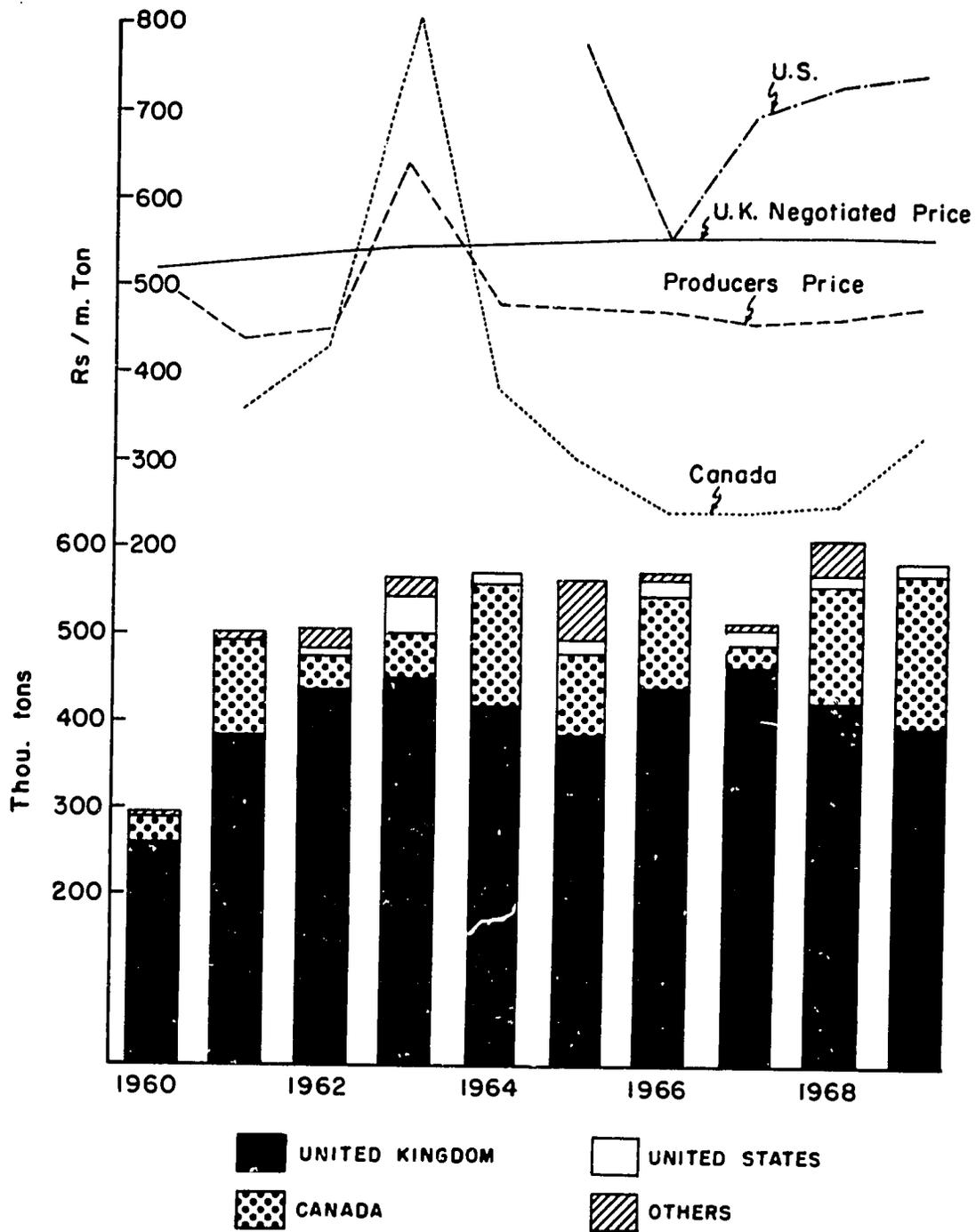
Sudden drops in the price of sugar are felt most acutely by those countries for which the world "free market" for sugar is the only outlet, or those like Mauritius and Cuba which depend almost exclusively on sugar as an export crop. The situation of a number of countries (including Mauritius and Cuba) is partially mitigated by the existence of bilateral agreements which set up stable, remunerative prices to producing countries, such as the Negotiated Price Quota (N.P.Q.) of Britain or the United States. "Free market" prices and conditions nevertheless indirectly influence the world sugar production, since pricing in preferential markets has some relation to values in the "free market" and conditions national policies of support or protection accorded to production and imports.

Mauritius sells on the "free market" about 30 percent of her production, the remainder after selling at N.P.Q. terms about two-thirds of her output to Britain and a small quota allocated by the United States which is less than 3 percent of Mauritian sugar production. The level and direction of the island's sugar trade during the last ten years is illustrated in Figure 10, and indicates the importance of the international "Agreements" to which the country subscribes. The main sugar agreements presently affecting Mauritius are: the Commonwealth Sugar Agreement, the U.S. Sugar Quota Agreement, and the International Sugar Agreement.

Sugar Agreements

The British Commonwealth Sugar Agreement (C.S.A.) covers 21 percent of the total world trade in sugar. It is the system used by the United Kingdom to control her supplies of sugar. Canada, New Zealand, Hong Kong and Malaysia are, besides Britain, the main sugar importers of the Commonwealth. The C.S.A. has considerable importance for those countries like Mauritius, Fiji, and West Indies whose economies depend almost entirely on sugar. This agreement has enabled the United Kingdom to protect her beet sugar industry but also permits flexibility in sugar movement within the Commonwealth. The C.S.A. creates a sense of cooperation among the countries of the Commonwealth providing considerable financial advantages to the exporting countries.

FIGURE 16. MAURITIUS: MARKETS AND NET PRICES OF SUGAR 1960 - 1969



Based on data in: Mauritius Chamber of Agriculture, The Presidents Report 1963/64 - 1969/70
 Mauritius Customs and Excise Dept. Annual Reports, 1965, 1969

The C.S.A., first signed in 1951, is a long term agreement between the countries of the Commonwealth. It establishes an Overall Agreement Quota of 2.78 million tons, of which 1.75 million tons is at a negotiated price well above the world market price for sugar (Figure 8). The price is established by negotiations between U.K. government officials and representatives of the exporting countries acting jointly (27, p. 119). The Commonwealth countries have an "International Quota" which is the amount by which their total net export entitlement under the International Sugar Agreement exceeds their Commonwealth Overall Agreement Quota.

About two-thirds of U.K. sugar imports are obtained from the Commonwealth countries, mostly in the form of raw sugar. About one-tenth of the sugar which Britain imports from non-Commonwealth countries is in the refined state and comes from European countries. The United Kingdom exports less than half a million tons of refined sugar per year. U.K. sugar trade is summarized in Table 6.

Table 6. U.K. TRADE IN SUGAR, AVERAGE 1962-68*
(thousand tons)

Foreign Refined Sugar	68
Raw Commonwealth Sugar	1,756
Australia	416
Fiji	137
Mauritius	422
Guyana	120
Jamaica	228
Trinidad	133
Barbados	126
Other	174
Foreign Raw Sugar	215
TOTAL Raw Sugar, All Countries	2,126
Exports, Refined Sugar	324

* Data from Commonwealth Secretariat, Plantation Crops, A Review, The Commonwealth Secretariat, London 1970.

The West Indies and Guyana with 725,000 tons of sugar, Mauritius with 380,000 tons, and Australia with 335,000 tons have the highest Negotiated Price Quotas for 1969, 1970 and 1971. The difference between the Overall Agreement Quota and the Negotiated Price Quota is bought by the U.K. Sugar Board at the London daily price plus the preferential tariff of 6/15/0 per ton. The prices obtained on the other Commonwealth markets consist of the world price plus preference tariff.

The last triennial meeting of the parties to the C.S.A. took place in 1968. The Negotiated Price Quota was fixed at the same level as for the three preceding years, i.e., £ 43/10/0 per long ton f.o.b.s. bulk sugar 96°pol. for all exporting territories. For the less developed ones an additional fixed element of £ 1/10/0 per ton and a variable element ranging from £ 2/10/0 to nil was assessed on the basis of the average world price in recognition of the dependence of the economies of these countries on sugar (7, p. 232). Mauritius benefits from these special considerations.

The C.S.A. will be of indefinite duration, subject to triennial review, the first of which will be in 1971. If the U.K. joins the E.E.C., she will not be committed to her contractual obligations after December 31, 1974. Outside this caveat, from 1969 the Agreement will run for 9 years without any possibility of major changes except those mutually agreed on by the participants (32, p. 8). Mauritius can therefore reckon on these concessions until 1978, unless Britain joins the E.E.C.

The U.S. Sugar Quota Agreement is the most important of all the sugar agreements. The U.S. requirement of 10.8 million short tons for 1970 represents about 15 percent of the world production and 25 percent of the world's annual imports. The Secretary of Agriculture determines each year the estimated domestic requirements for the ensuing year at prices believed to be fair to producers and not excessive to consumers. By law, Congress specifies the shares for each domestic and foreign producing area. Thirty percent of U.S. needs consists of sugar beet grown in the U.S., and the remainder is cane sugar from the southern U.S. and offshore islands, Hawaii, Puerto Rico and Virgin Islands, and foreign countries. The foreign producers, excluding the Philippines, are apportioned about 28 percent of the total requirements, for which there is keen political competition. Mauritius has a share of this slice of the pie (38, p. 1057).

As Figure 8 shows, the U.S. "quota price" is much higher than the world free market price. This very remunerative price gives the U.S. a considerable importance in world sugar politics, deciding which countries shall have a quota and how large these quotas will be. The allocation of quotas is of course dependent upon the relationships that exist between the foreign countries and the U.S.; at present, Mauritius/U.S. relations are satisfactory, and the quota is operational.

The International Sugar Agreement came into operation in 1954. Its objectives as defined by the 1953 and 1958 agreements were to:

"...assure supplies of sugar to importing countries and markets for sugar to exporting countries at equitable and stable prices...to contribute to improvement of living conditions of customers throughout the world in the maintenance of the purchasing power in the world markets of producing countries or areas and especially of those whose economies are largely dependent upon the production or export of sugar..." (52, p. 42).

The agreement limited the quantities of sugar which member countries could import from non-member countries and fixed the minimum level of stocks at 12.5 percent of basic export tonnages. A system of export quotas was established to regulate total supplies available to the "free market," taking into consideration the special trading arrangements of major economic trading groups (52, pp. 44-48).

All the economic and regulatory provisions of the agreement became inoperative when the sugar market was disrupted in 1961. Cuba exceeded her export quota causing the price to fall to 2.15 cents per pound, while price specified by the agreement was 3.25 - 4.25 cents per pound of raw sugar. It was difficult to control exports and even more difficult to control imports. There were too many conflicts between national policies and declared international objectives.

On April 17, 1968 the International Sugar Conference opened again, and Mauritius attended this conference in her own right for the first time since her independence. The I.S.A. entered into force on June 17, 1969, and at the beginning of 1970 its membership comprised of 13 importing countries and 34 exporting countries. The representatives of U.S.A. and E.E.C. have attended the meetings as observers and have up to now not joined the agreement. The Mauritian delegate was elected chairman of the Executive Committee for 1969 and again in 1970. The new agreement contains special provisions with regard to exports under the Commonwealth Sugar Agreement; exports by Cuba to socialist countries; exports under the African and Malagasy Sugar Agreement; exports to the United States of America; and to re-exports by the U.S.S.R. Such exports are not chargeable against quotas in effect under the International Sugar Agreement. The basic export tonnages fixed in the agreement are as shown in Table 7.

Table 7. BASIC EXPORT TONNAGES UNDER I.S.A.*

Exporting Country	Metric Tons (thousand)
Cuba	2,150
Australia	1,100
China	630
South Africa	625
Brazil	500
Poland	370
E.E.C.	300
Czechoslovakia	270
India	250
West Indies	200
Mauritius	175

* Data from Mauritius Chamber of Agriculture, President's Report, 1968-69, p. 10.

The International Sugar Council estimated the free world market requirements at 8.5 million metric tons raw value and the export quotas were fixed at 90 percent of basic export tonnages for 1969. This was maintained for 1970, in order to bring supply and demand into balance. Shortfalls in supply can be redistributed through the Hardship Relief Fund if the prevailing price rises above 3.75 cents per pound. Mauritius was one of the claimants from that Fund and qualified for an allocation of 35,000 tons because of its heavy dependence on sugar for export earnings.

In the world "free market," from which Mauritius must find purchasers for a third of her sugar exports, the countries of Southeast Asia and the Far East have been very irregular customers. The expanding markets of Japan, Hong Kong, Singapore, and Malaysia which could be a valuable outlet for Mauritius are considered to be a dumping ground for the unprotected portion of their sugar production by the world sellers, and competition for these markets is very severe. However, Canada has come to represent practically the sole outlet for Mauritian "free market" sugar, and shipments to Canada have increased sharply during the last three years (see Figure 10).

Canada buys sugar at a price exceeding the world price by the Commonwealth preference tariff; the preferential rate of duty is one dollar per 100 lbs. less than the Most Favored Nation rate on raw sugar (32, p. 5).

Future of Sugar

Sugar is a most difficult commodity to forecast future trends. The sugar market, besides reflecting supply and demand situations, is affected by the vagaries of climate and politics in all parts of the world. The former vary the level of output, while the latter affect both production and consumption. The production and consumption of sugar have more than doubled in the post-war period, but while world consumption has been increasing more or less steadily at 3.5 percent per annum over recent years, production has been more variable, responding to prices and climatic conditions.

At constant 1961-63 prices the world demand for sugar in 1975 was estimated by the FAO at between 75.6 and 80.5 million tons. World sugar production is given as 79.6 to 90.6 million tons (14, pp. 182-94). The upper limit is thus much in excess of projected volumes of consumption.

The general theoretical tendency is for production to be greater than consumption, but in practice the production tends to adjust itself roughly to the development of consumption. A large part of the production increase should come from those countries tending toward self-sufficiency (like Kenya, Tanzania, Nigeria, and Ghana in Africa, and Uruguay and Chile in South America). The traditionally exporting countries will have to restrain their production as those territories which were net importers increase their national production of sugar. This impetus toward diversification of agricultural economies is responsible for the expansion of domestic sugar production despite the low prices prevailing on the world market. Since sugar industry needs heavy capital investment, both in terms of material and human elements, it might be more advantageous for small countries to import from specialized producers at low prices, but politics more than economics guides the decision. The net result is one more source of market imperfections on the supply side, which debilitate the comparative advantage theory's usefulness to world sugar trade, and make unwise the continued dependence of Mauritius on this one crop.

The future of the Mauritian sugar trade depends on: a) the admission of Britain to the E.E.C.; b) U.S.A.-Mauritius political relations; and c) the supply and demand situation on the world "free market."

Effect of E.E.C. on Mauritian Sugar

The E.E.C. has had considerable influence on the sugar production and trade of the six European partners, France, West Germany, Italy, Belgium, Netherlands, Luxembourg and the Associated Territories. The total E.E.C. trade in sugar is less than 2 percent of the world market total. The production within the E.E.C., on the other hand, is more than 7.5 million tons, i.e., about 11 percent of the world's output. The six countries of the E.E.C. and Guadeloupe, Martinique, and Reunion produce 98 percent of the sugar needs. They import the remaining requirement of raw sugar, however, at stable and profitable prices much better than those obtained on the world free market and even than the negotiated price of the C.S.A.

In the event of admission to the E.E.C., the United Kingdom has undertaken to consult with other parties of the C.S.A. with a view to "seeking means of fulfilling the objectives which those obligations would otherwise fulfill" (32, p. 8). In February 1970, a Mauritian ministerial mission discussed the Mauritius sugar problems with the government of the U.K. and those of the E.E.C. countries as well as the E.E.C. commission. No final decisions were reached.

U.S. and Mauritian Sugar

A firm of lawyers in Washington, D.C., has been appointed to act as lobbyists to secure a larger U.S. quota. It is difficult at this juncture to foresee the direction of the implications of Mauritius' granting landing rights and trawler facilities to the U.S.S.R. on the future U.S. quota; it certainly has attracted a little more attention of the United States government to the plight of Mauritius.

Conjecture is probably of little value at this stage as to the effects on the economy of Mauritius should the U.S. withdraw its sugar quota allocated to the island, and should Mauritius, in turn, decide to direct its sugar trade toward countries of the Communist bloc.

Communist Bloc and Mauritian Sugar

The centrally planned economy group of countries, composed of the U.S.S.R., China, Cuba and Eastern Europe, represent 27 percent of the world's total sugar consumption. The trade of these countries operates mainly through bilateral agreements which often take the form of long-term barter trade and make evaluation of the exact terms of trade under such conditions impossible. There has been a rapid rate of increase in per capita consumption in these countries in recent years. Since 1961, Cuba has sold a large part of her crop, more than 3 million tons yearly, to the centrally planned countries.

A part of the imports of the U.S.S.R. find their way back to the "free market." This amounted to about 1.5 million tons in 1965-69, as an average. It means that what was imported from Cuba was re-exported at world market prices, causing the fall in world prices. While all the imports of the U.S.S.R. came from countries of the Communist bloc, very little was exported to that group of countries. China also imported from Cuba about 488,000 tons average between 1965 and 1969 and re-exported about 320,000 tons mainly to non-Communist countries. Whether it would have been possible for Cuba to sell her sugar directly on the world market without the unnecessary intermediaries and the transport and handling charges involved is a difficult political question.

Although the world's demand and supply picture of sugar for the future seems bleak, it does not necessarily follow that Mauritius as an individual country cannot turn to its advantage some of the market imperfections of the trade. Even in the "free market" Mauritius has been able to secure a foot-hold on the Canadian market which constitutes a valuable, if the only, outlet there at present. Representations were made to the Canadian Tariff Board to secure the maintenance of the level of present Commonwealth preference. The Board was to submit its report to the Minister of Finance at the end of 1970.

These multiple uncertainties about the future of Mauritian sugar market emphasize the importance of diversifying the country's exports. Sugar trade alone is no longer certain to assure foreign exchange earnings at the level necessary for the import of food and consumer durables not produced in the island and for the import of capital goods prerequisite to increased industrial development.

Mauritius and the World Tea Situation

Tea is the second most important foreign exchange earner in Mauritius. The island has embarked on a costly development program to bring the acreage under tea cultivation from its 1969 acreage of 8,100 arpents to 30,000 arpents at a rate of 2,000 arpents per year from 1971 onward. Tea has the advantage of being the crop best suited to the higher superhumid areas of the island, of being like sugar cane resistant to cyclones, and of being labor intensive. Unfortunately, like sugar, tea is facing problems on the international market.

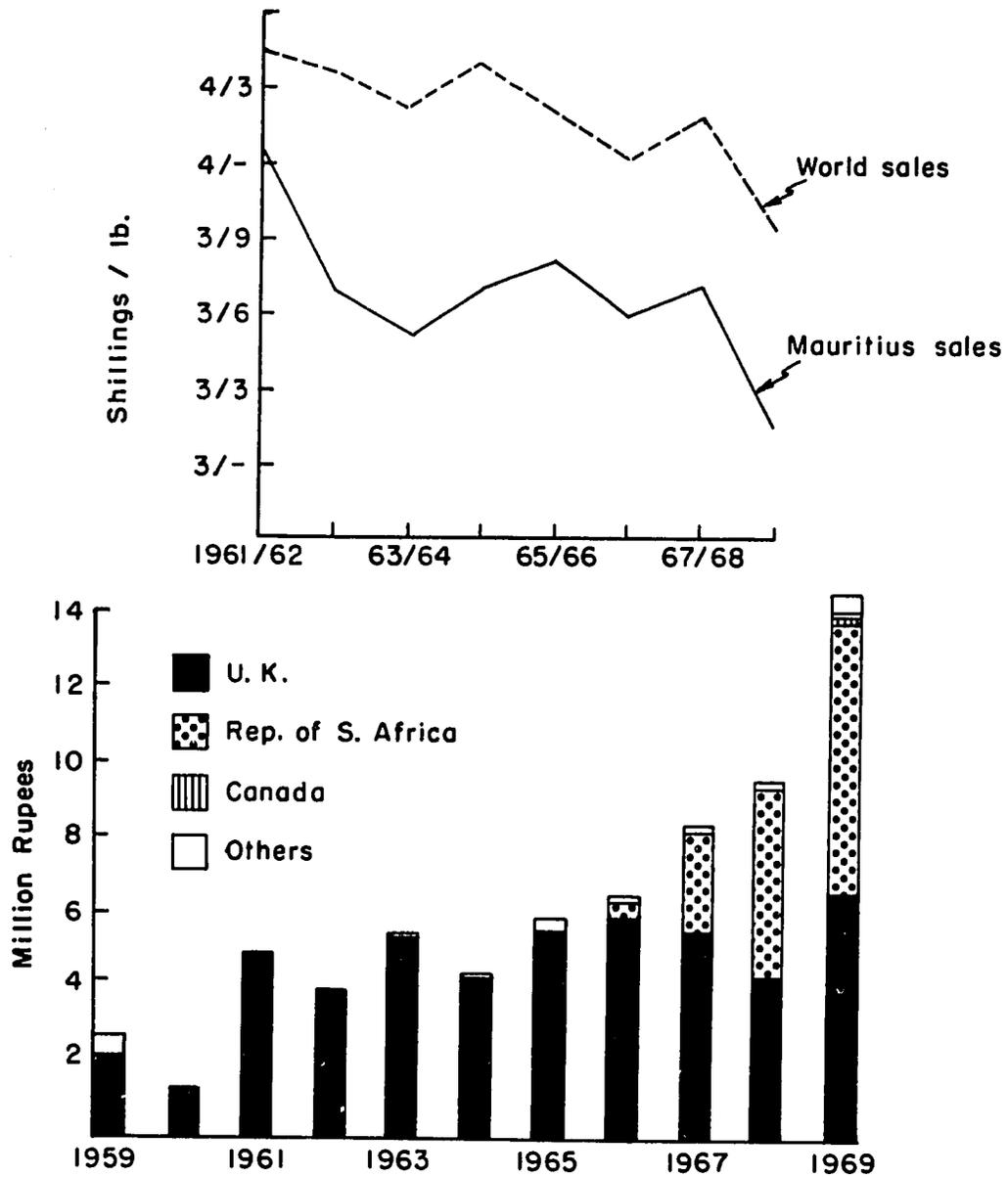
World tea production has expanded by more than 30 percent in the last decade; excluding mainland China, production reached a new record of 1,080 million kilos in 1968. Tea, which is produced on an extensive scale mostly in Asia, has been expanding very rapidly in East Africa, where the acreage under tea doubled in the past 10 years, and is being developed in several Latin American countries. In Mauritius production increased by 87 percent in the last 5 years. The expansion of tea production by small holders is encouraged by the long term loans of the International Development Association (I.D.A.) and of the Commonwealth Development Corporation. Mauritius also obtained a loan from the I.D.A. for a tea settlement scheme.

Consumption of tea, however, has not expanded at the same rate as production, and this has resulted in accumulation of stocks and serious declines in prices. Increases in consumption have occurred primarily in the producing countries in recent years.

UNCTAD has forecast that world demand for tea will increase by about 7 million kilos annually, but supplies available for export in 1970 were far in excess of the increased requirements. In 1969 a meeting of delegates of major tea exporting countries was held in Mauritius to consider the price decline. The average world price had reached its lowest level in 15 years (see Figure 11). It was decided to remove from the market 40,000 tons or 7 percent of world exports, and quotas were assigned to exporting countries. Mauritius agreed to abide by the quota set for 1970, but has indicated that because of the importance of the Tea Development Program for the economy, the island could not commit herself to accept any long-term agreement about quotas.

Mauritius has been actively prospecting markets for her expanding tea production, in spite of the depressing world tea situation. The potential for tea export on a larger scale does not appear too pessimistic for Mauritius, as many of the countries from which the island gets a sizeable part of her imports are tea importers and presently import very little, if at all, from Mauritius. As a result of representations made by the Mauritian government, the Republics of South Africa and Malagasy have agreed to increase their tea imports from Mauritius. Imports by the Malagasy Republic have doubled between 1967 and 1968, while those from the Republic of South Africa have trebled (see Figure 10). A major South African importer has agreed to purchase an

FIGURE 17. MAURITIUS: TEA EXPORTS 1959-1969 AND AVERAGE PRICES ON LONDON MARKET 1961/62 TO 1968/69



Based on data in Mauritius Tea Control Board: "Statistical Review for Contractual Year, 1969" Government Printer, Port Louis, 1969

additional 250,000 kilos by the end of 1970 and to purchase 2.5 million kilos of tea during 1970/71 subject to agreement being reached concerning grade and price (32). This implies a 100 percent increase in tea exports to the Republic. These increases in tea exports will help to breach the gap in the balance of payments, although tea is still only about 4 percent of total exports.

International Trade Prospect

The major export commodities, sugar and tea, have not been able to improve the balance of visible trade in the past decade and their future on the world market is not very promising either. If the gap in the balance of visible trade is to be filled, it seems that it should be by decreasing the level of imports. This may be brought about by import substitution. Some import substitution has been attempted largely in the industrial sector where its total effect is dampened by the need of these transformation industries which have been established to import much of the semi-finished material they use. Examples of these are industries dealing with cosmetics, stationery, batteries, packaging, edible oil, metallic windows and doors, nails, among others. The imports of raw materials are low and the average of the last 3 years is only 10 percent higher than that of the previous 3 years, while the imports of manufactured goods has not shown any appreciable decrease, indicating the low progress of industrialization.

Food Import Substitution

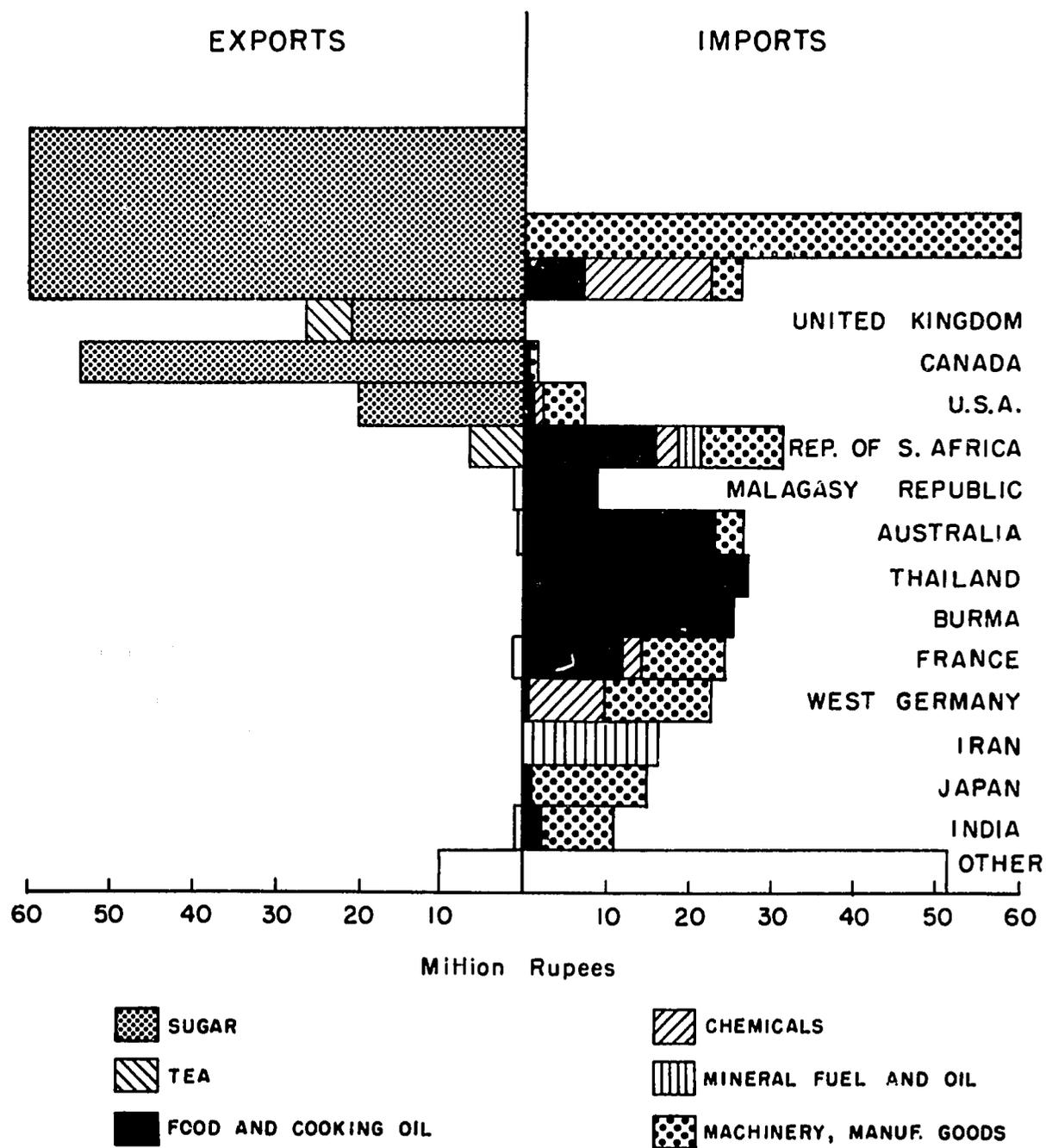
On the other hand, the total value of food imports has been increasing steadily due to increases in population and prices, and now represents more than a third of total imports. Food imports seem to be the best target for import substitution. As can be seen in Figure 12, countries which supply food to Mauritius (Thailand, Burma, Madagascar, et al.) are not generally important export markets for sugar, thus there is a lessened danger of retaliation against Mauritius should the island adopt a food import substitution plan. Most types of imported food can be produced locally. Local production of food presently imported could help not only in bridging the balance of visible trade gap, but at the same time create employment opportunities.

The value of per capita imports of food and edible oils has increased by more than 45 percent between 1959 and 1968. The increase in the demand for food of all categories due to population increase as well as redistribution of income has not been met by increases in local production. The per capita expenditure on imported foods has increased from 55 percent to 60 percent of all food expenditures between 1958 and 1967 in spite of the increase in prices of imported food as compared with prices of local food.

Effects of Sugar Price on Imports

The changes in the values of imports of the different commodities from year to year (see Table 8) are due partly to changes in the export earnings of sugar and partly to price changes. A correlation exists between the income received from sugar exports and the expenditure on almost all food imports for the following year.

FIGURE 18. MAURITIUS : VALUES AND DIRECTION OF TRADE
AVERAGE 1965 - 1969



Based on data in Mauritius Customs and Excise Department Annual Reports
1965 - 1969

The food imports tend to rise following a good sugar year while expenditures on local food products fall. A bad sugar year, however, has not got a completely opposite effect, as the food imports remain relatively constant while the local food consumption rises (37, p. 337). In 1967, the devaluation of the rupee caused a decrease in the volume of imports of products coming from countries which did not devalue when Britain did. This affected imports of products like pulses, edible oil, and rice.

Table 8. IMPORTS 1961-1969 AT CURRENT PRICES*
(Rs. million c.i.f.)

S.I.T.C. Sections	1961	1962	1963	1964	1965	1966	1967	1968	1969
Food	88.9	93.0	94.7	105.9	108.0	109.6	118.5	135.5	132.6
Beverages and Tobacco	8.4	8.1	7.9	7.4	6.8	4.9	4.8	5.7	5.3
Crude Materials, Inedible except Fuel	8.2	6.3	5.6	6.5	6.7	5.4	7.1	7.8	5.6
Mineral Fuels, Lubri- cants, etc.	11.9	15.5	14.2	17.0	17.7	15.4	25.4	35.8	31.7
Animal and Vegetable Oils and Fats	10.3	10.7	12.1	11.3	14.9	17.7	18.3	18.5	12.5
Chemicals	36.0	37.2	39.7	46.4	47.1	45.6	42.6	49.0	43.0
Manufactured Goods Classified Chiefly by Material	76.0	70.9	70.8	88.5	78.6	70.2	78.5	77.6	72.4
Machinery and Trans- port Equipment	53.7	45.4	55.7	70.3	56.3	36.9	43.7	56.5	44.7
Miscellaneous Manu- factured Articles	29.9	34.9	31.7	35.5	31.0	27.4	32.1	34.6	27.9
Miscellaneous Transac- tions and Commodi- ties n.e.s.	0.9	0.7	0.8	0.1	0.3	0.2	0.1	0.1	0.1
TOTALS	324.0	322.7	333.1	388.9	267.3	333.2	371.1	421.1	376.0
Retained Food Imports as % of Total Re- tained imports	31.1	32.5	32.1	30.4	33.8	37.9	36.5	36.4	38.3
Exports	294.0	306.0	428.0	366.0	367.3	337.0	306.0	354.0	365.0

* Data from Mauritius Central Statistical Office, Digest of Statistics, 1961-1969.

Since food imports play such an important part in the balance of payments, this depressing effect will most probably increase in the future with the increase in population. The situation will worsen unless there is an increase in exports, a decrease in the already low level of food consumption, or an increase in the local production of food. The future of sugar and tea has already been shown to be very uncertain. The changes in the level of exports and imports necessary to maximize the balance of payments will be determined empirically later, demonstrating what scope exists for import substitution in the agricultural sector.

THE SCOPE FOR IMPORT SUBSTITUTION

Food Import Dependency

Mauritius is an agricultural country, and the scope for import substitution for food is great, but must not be exaggerated. Limitations are imposed by the size of the local market, by the land resources and climate, and by the difficulty of effecting the necessary structural changes in domestic agricultural production.

The deficiencies in local supply are due to the interaction of complex institutional social and economic factors besides climate, the most important factor is probably the strong pull which the well organized sugar industry exerts on capital, skills, land, and labor. Climatic factors prevent the cultivation of wheat and severely restrict the production of rice, milk, beef and certain fruits. The level of technology available to the farmer interested in production of crops other than sugar cane is low, yields are therefore low and, combined with the high labor inputs, increase the cost of production. The inadequate marketing infrastructure and organization available for products other than sugar, tobacco, and tea, and in recent years potatoes and onions, make it difficult for local producers to compete against cheaper imported substitutes so easily available on the market. The net result is the relative unimportance of local food supplies. The two major staple foods, wheat and rice, are both imported. Their relative importance has altered in the last 10 years. The higher price of rice and other social factors caused the per capita consumption of rice to decline and that of wheat flour to increase between 1962 and 1969 (see Table 9).

Food Consumption Patterns

The composition of the Mauritian diet has evolved as the ethnic composition of the population and prevailing economic conditions varied. Our knowledge of the dietary pattern of Mauritius is based on the household budget survey carried out in 1961-62 (48), and an anthropological survey carried out in 1960, as well as other nutritional surveys (3, 53). The household budget survey is the most recent and valuable and contains a large amount of data which have been partly analyzed in two recent studies on the food situation in Mauritius (37, 50).

The general pattern that emerges from the dietary studies is that the Mauritian diet resembles that of the Indian subcontinent despite the island's plural society and its being African by geographical and political volition.

There are slight differences in diet among different ethnic groups, between men and women and between various occupations (3, p. 81). The average Mauritian diet consists of rice and wheat flour as the main starch staples, eaten together with vegetables, pulses and small quantities of fish and meat as illustrated in Table 10. Wheat flour is eaten in the form of bread or as "roti," a flat dough cake which forms part of the diet of most Indo-Mauritians. The menu consists generally of tea, highly sweetened with sugar, rice or bread or "roti" in the morning, rice or bread or "roti" with dry pulses, a leafy vegetable, curry, and sometimes salt fish for the mid-day meal, and for the evening meal again rice or "roti," curry vegetables and salt fish, or

more rarely fresh fish or meat. Although the meals seem to follow the same pattern, there is considerable variety in the diet because of the wide range of vegetables and pulses.

Table 9. ANNUAL PER CAPITA CONSUMPTION OF SELECTED
FOODSTUFFS, 1960-1969*
(kilos)

Commodities	Average 1960-64	1965	1966	1967	1968	1969	Average 1965-69
Sugar	38.3	42.6	39.1	40.2	38.1	38.8	39.8
Potatoes	10.3	9.3	13.3	14.3	14.4	n.a.	n.a.
Dried Peas and Beans	n.a.	4.0	3.9	3.9	3.3	3.2	3.7
Vegetables	33.6	27.8	27.9	25.1	22.2	20.5	24.7
Peanuts	1.0	0.9	1.3	1.4	1.1	1.1	1.2
Edible Oil	9.7	11.5	13.4	13.7	13.0	9.7	12.3
Tomatoes	7.2	7.3	7.5	11.8	11.2	10.7	9.7
Onions	n.a.	3.6	3.9	3.3	3.2	3.7	3.5
Rice	95.8	87.4	84.7	80.7	81.7	81.1	83.1
Wheat Flour	36.8	47.9	40.3	45.2	46.1	54.3	47.1
Maize	n.a.	7.1	5.3	5.7	9.0	6.4	6.7
Root Crops	1.9	1.4	1.5	1.4	1.2	1.2	1.3
Tea	n.a.	0.7	0.7	0.7	0.7	0.6	0.7
Beef	3.9	3.3	3.2	3.6	3.3	3.0	3.3
Milk	54.6	58.0	62.4	53.7	56.1	55.6	57.2
Bananas	n.a.	13.9	11.9	12.8	13.7	14.3	13.3
Imported Fruits	2.1	2.2	2.5	2.5	2.0	1.4	2.1
Garlic	n.a.	0.5	0.4	0.6	0.6	0.3	0.5
Pineapples	n.a.	0.4	0.6	0.6	0.8	0.8	0.7
Pulses	8.8	8.0	8.2	6.5	7.0	6.4	7.2

* Data from E. Simmons, "The Food Balance Sheet as a Parameter of Tropical Food Economies: The Case of Mauritius," unpub'd M.S. Thesis, Cornell University, 1968; Customs and Excise Department Annual Reports, Central Statistical Office, Digest of Statistics, Mauritius.

The imported cereals, rice and wheat flour supply the bulk of the calories and proteins. Other sources of protein also imported are pulses mainly from beans, lentils, and peas; milk and milk products; and fish, mostly salt fish. Fresh fish and meat are eaten more rarely, usually on festive occasions because of their price.

The consumption of sugar is high because it is very cheap; the retail price of sugar in Mauritius is one of the lowest in the world. Sugar is also consumed heavily in tea drinking and sweetened foods. Oils and fats consumption is also high since dietary traditions and cooking practice tend to frying instead of boiling foods.

Table 10. MAURITIUS: AVERAGE HOUSEHOLD FOOD COMMODITY EXPENDITURES 1961-62*

Commodities	Percent of Total Expenditure	
Cereals		35.4
Government Rice	17.8	
Traders Rice	5.1	
Flour and Bread	9.0	
Other	4.5	
Meat		7.6
Beef and Veal	4.7	
Poultry	0.5	
Other	2.4	
Fish		7.6
Oils and Fats		9.6
Cooking Oils	7.0	
Other	2.6	
Dairy Products and Eggs		8.1
Fresh Milk	5.2	
Processed Milk	1.9	
Other	1.0	
Vegetables		15.7
Pulses and Legumes	4.5	
Tomatoes	2.8	
Potatoes	2.7	
Other	5.7	
Fruits and Nuts		2.5
Sugar		4.7
Other Food, Spices		3.9
Non-alcoholic Beverages		4.9
Tea	2.4	
TOTAL		100.0

* Data from M. Milliken and Lim Fat, "Population Growth, Income Change and the Demand for Food In Mauritius," *Revue Agricole et Sucriere de l'Ile Maurice*, Vol. 47, no. 4, p. 342, 1968; and Appendix III of the 1961-62 Household Budget Survey Report.

Effect of Higher Income on Food Consumption

A rise in the level of income results in an increase in the level of consumption and changes in the structure of the diet. Another way of saying this is that the demand for food in Mauritius is extremely sensitive to income changes, so that an increase of 10 percent in per consumer income would lead the Mauritian consumer to increase his expenditure on food consumption by 6.2 percent. This great income elastic food demand, usually associated with low income countries, is particularly evident as Mauritius is a wage economy in which more than 95 percent of food consumed by households (participants in the 1961-62 household budget survey) was purchased through commercial channels and less than 3 percent obtained from home grown or

collected foods (37, p. 372). Within the limitations set by income, as well as by nutritional requirements and dietary traditions, the consumption pattern is also strongly influenced by relative prices of commodities available to the consumer. Cereals, mainly rice and wheat flour, sugar and cooking oils are relatively cheap, while milk, meat and fish are relatively expensive. The prices of vegetables fluctuate considerably during the year, but there are plentiful supplies at all times except after cyclones. A commodity breakdown of consumer spending on food in 1961-62 (summarized in Table 10) shows that almost 50 percent of average monthly food expenditures were made on the cheaper foodstuffs listed above.

However, the household budget survey also revealed that as income rises, the pattern of food expenditures tends toward the more preferred and expensive foods such as traders' rice, butter, meat, fruit, and fish, while purchases of cheaper commodities decrease. Although in Mauritius the average real consumption of food per capita has not changed very much since 1962, there has been an overall increase in real expenditure on food, and a change in the relative importance of different items in the diet such as might be predicted from a rise in income.

This trend in the pattern of consumption is probably due to an improvement in the wages of lower income groups. Wages on the sugar estates and in other industries and services have risen repeatedly between 1962 and 1969, although the effect of increases has been dampened by the rise in the cost of living. Another indication of redistribution of income is that per capita social security payments grew from Rs.23 in 1958/59 to Rs.65 in 1966/67 (36, p. 78). Beneficiaries of these increments in income devote a large part of the increase to expenditures on food, and expand their consumption of the more expensive sources of calories and proteins.

Food Aid Program

An exogenous factor which complicates the further analysis of the present food situation is the overseas food aid program, which started at the end of 1969. The world food aid program project provides a free supply of milk, bread and dried fruits to all school children. The total calorie and protein supply represented by this input will most probably affect the food consumption and supply pattern. The program will last 5 years and will certainly upgrade the nutritional status of the school children. The program will probably also have its impact on the purchases of families in the lower income groups and the character of the national diet. The (P.L. 480) food aid program used to pay partly in kind the workers on the tea development projects will also affect the food situation.

In any case, one may assume that as the population of Mauritius grows, its aggregate need for food will increase regardless of the consumption pattern which obtains. Thus, population is the single most important variable affecting the country's future food demand and overseas supply needs.

Future Food Demand

The projection of food demand for Mauritius for 1975 and 1980 has been calculated on the basis of per capita consumption and population. This projection does not take

into account the income elasticity of demand for 3 major reasons. First; between 1958 and 1967, 99 percent of increased expenditures on food was due to population growth, and less than 1 percent was attributable to long-term growth of the gross national product. Secondly, no data are available on income distribution within the island making it impossible to quantify effects of any possible redistribution of income. Thirdly, it is unlikely that under present circumstances Mauritius' GNP per capita will rise higher than the rate of growth of population by any appreciable extent in the next decade. The demand for food in 1975 and 1980 was therefore calculated on the basis of a constant consumption pattern equivalent to the average per capita consumption of major food commodities from 1965-69.

The average per capita consumption was calculated from the data on gross food supply from figures on local production and imports, adjusted for quantities exported, accumulated as stocks and utilized for non-food purposes. The average per capita consumption of selected foodstuffs for the 1960's is summarized in Table 9. The aggregate consumption levels for each commodity have been determined for high and low population projections to 1975 and 1980. The meaning of the distinct rates of population growth for food consumption, and the average per capita consumption of major food items from 1965-1969, is shown in Table 11.

The levels of future food demand in Mauritius in 1975 were also determined by the FAO (14) using different combinations of high and low rates of population expansion with high and low rates of private consumption expenditure. The FAO projections are summarized in Table 12. The income elasticities used in the computations were those of countries with similar levels per capita of gross domestic product as Mauritius.

Food demand projections for 1975 were also computed by Milliken and Lim Fat (37) using income elasticities obtained from the 1961-62 household budget survey and different assumptions of the rate of growth of real GNP and the average rate of population growth of 2 percent per annum compound. The results are depicted in Table 13.

We consider that our projection gives a more realistic picture of what the food demand will be in 1975 than the two other projections, in spite of the less sophisticated methodology. The reasons for our contention are:

a) We have expressed the food demand in terms of quantities rather than in terms of expenditure on the commodity or in terms of indices. It is therefore more practical for direct use.

b) We use the average expenditures of 1965-1969 as a base period, while the FAO projections employed 1960-62, and the other projection used the single year 1964. There are thus important differences in the pattern of consumption implicitly chosen as base, and the more limited perspectives offered by the other 2 projections on consumption patterns have been compounded over time. Our projection using a constant expenditure pattern also lends itself to criticism but has the advantage of being based on broader and more recent consumption data. The margin of error for 1975 will be therefore most probably minimal while that for 1980 may be quite important, but all projections have to take that risk.

c) We have used new population projections which take into consideration the trends in birth rate between 1963 and 1969 which are so completely different from the previous trends, and we have also taken the recent emigration trends into account.

Table 11. PROJECTIONS OF FOOD DEMAND*

Commodities	Per Capita 1965-69 (kg./year)	Total Population Needs (thousand metric tons)			
		1975L	1975H	1980L	1980H
Cereals	130.6	114.1	118.1	121.6	133.9
Wheat	47.2	41.2	42.7	43.9	48.4
Rice	83.1	72.7	75.7	77.4	85.3
Coarse Grain	2.5	2.2	2.3	2.3	2.6
Starchy Roots	13.6	11.9	12.3	12.7	13.9
Potatoes	12.2	10.7	11.1	11.4	12.5
Others	1.4	1.2	1.3	1.3	1.4
Sugar	39.8	34.8	36.0	37.0	40.8
Pulses and Nuts	9.4	8.2	8.5	8.8	9.6
Pulses	7.2	6.3	6.5	6.7	7.4
Vegetables	24.1	21.1	21.9	22.5	24.8
Fruits	14.0	12.2	12.7	13.0	14.4
Meat	6.6	5.7	5.9	6.1	6.7
Beef and Veal	3.2	2.8	2.9	3.0	3.3
Mutton and Lamb	0.9	0.8	0.8	0.8	0.9
Pork	0.7	0.6	0.6	0.6	0.7
Poultry	0.7	0.6	0.6	0.6	0.7
Others	1.1	1.0	1.0	1.1	1.2
Eggs	2.5	2.2	2.2	2.3	2.6
Fish	5.3	4.6	4.8	4.9	5.4
Milk, excluding Butter	57.2	50.0	51.7	53.2	58.7
Fats and Oils	15.1	13.2	13.7	14.1	15.5
Vegetable Oils	12.9	11.3	11.7	12.0	13.2
Butter	0.4	0.4	0.4	0.4	0.4
Others	1.8	1.6	1.7	1.7	1.9
POPULATION ESTIMATES		874,028	904,785	941,389	1,025,895

* Data from Central Statistical Office, Digest of Statistics, 1965 to 1969; Mauritius Customs and Excise Department Annual Reports, 1965 to 1969.

Table 12. PROJECTIONS OF PER CAPITA DEMAND FOR FOOD*

Commodity	1962	1965	1975L	1975H
	(kilograms per year)			
Cereals	132.5	134.5	136.5	141.4
Wheat	33.1	33.4	33.7	34.5
Rice	96.4	98.1	99.7	103.8
Coarse Grains	3.0	3.0	3.1	3.2
Starchy Roots	13.6	13.5	13.5	13.3
Sugar	38.4	38.8	39.2	40.3
Pulses and Nuts	12.2	12.4	12.7	13.6
Vegetables	32.0	32.6	33.3	35.6
Fruit	4.5	4.7	4.8	5.3
Meat	6.6	7.0	7.4	9.2
Beef and Veal	3.6	3.8	4.1	5.2
Mutton and Lamb	1.0	1.1	1.1	1.4
Pork	0.6	0.6	0.7	0.7
Poultry	0.3	0.3	0.3	0.4
Others	1.1	1.2	1.2	1.5
Eggs	1.7	1.8	1.9	2.3
Fish	12.9	13.4	13.9	16.2
Milk, excluding Butter	41.3	42.6	44.1	49.4
Fats and Oils	13.2	13.5	13.7	14.8
Vegetable Oils	12.5	12.6	13.0	13.9
Butter	0.5	0.5	0.6	0.7
Others	0.2	0.2	0.2	0.2

* Data from FAO Agricultural Commodities Projections for 1975 and 1985, Vol. II, p. 205, Rome, 1967.

The major differences between the bases used in our projection and those of the FAO, (14) are summarized below:

Food Item in kg./year Per Capita	FAO Study		Actual Consumption		Our Projection
	Base 1960-62	Projection 1975L	1962	1969	Base Average 1965-69
Wheat	33.1	33.7	36.7	56.2	47.2
Rice	96.4	99.7	95.8	81.1	83.1
Pulses and Nuts	12.2	12.7	7.8	9.5	9.4
Fish	12.9	13.9	6.7	5.3	5.3
Milk	41.3	44.1	50.2	55.6	57.2

Table 13. DEMAND FOR FOOD PROJECTED TO 1975*
(population growth 2 percent per annum compound)

Commodity Groups	Demand 1964 Rs.m.	Total Demand, 1975					
		2% <u>1</u> /		3% <u>1</u> /		4% <u>1</u> /	
		Rs.m.	Index	Rs.m.	Index	Rs.m.	Index
Cereals and Cereal Preparations	67.1	83.4	124.3	87.7	130.7	92.2	137.4
Meat, Meat Preparations, Poultry	29.3	36.4	124.3	42.1	143.7	48.6	165.9
Fish and Fish Preparations	13.7	17.1	124.3	18.4	134.3	19.8	144.5
Oils and Fats	21.5	26.7	124.3	28.9	134.4	31.1	145.6
Dairy Products and Eggs	26.3	32.7	124.3	35.2	133.8	37.8	143.7
Vegetables	31.2	38.8	124.3	41.1	131.7	43.1	138.1
Fruits and Nuts	9.8	12.2	124.3	14.5	148.0	17.1	174.5
Sugar, Sugar Preparations, Honey	14.2	17.7	124.3	18.6	131.0	19.6	138.0
Other Foods and Spices	9.5	11.8	124.3	12.5	131.6	13.1	137.9
Non-alcoholic Beverages	8.4	10.4	124.3	11.5	136.9	12.6	150.0
TOTAL FOOD	231.0	287.2	124.3	310.5	134.4	335.2	145.1

1. Annual increase in real G.N.P.

* Data from M. Milliken and Lim Fat, "Population Growth, Income Change and the Demand for Food in Mauritius," *Revue Agricole et Sucriere de l'Ile Maurice*, Vol. 47, no. 4, pp. 354-355, 1968.

The Milliken projections (37) are also different from ours. The choice of the base year 1964 was most unfortunate, as the expenditure on the different categories of food in that year was either at its highest (in most cases) or at its lowest, for the decade. It reflected the exceptionally good income received from sugar exports in the previous year. The projections are thus biased toward imported goods.

The expansion in food demands evidenced by the projections would put severe strain on the balance of payments. In the recent past, the import bill for those agricultural commodities like rice, milk, edible oil, etc. which can be produced in Mauritius had grown to 27 percent of total imports. As an average for 1967 to 1969, the possible import bill saving for those products amounted to more than 94 million rupees per year. Hence, the present government's efforts to encourage production of agricultural commodities as an import saving and employment creating measure is not only justified, but crucial. It is physically possible to supplant imports of rice, potatoes, peanuts, edible oil, preserved vegetables, onions, garlic, beans and peas with local produce (although the scope for substitution in rice, beans and peas, maize, and some preserved fruits and vegetables is presently somewhat limited by technical factors and/or the size of the local market). Projecting today's balance of payments difficulties into the future population and food demand (estimated) situation one can readily see that the sugar economy will find it increasingly hard, if not impossible, either to feed its citizens or to attempt economic transformation (for which capital goods must be imported) without more self-sufficiency in food production.

AGRICULTURAL RESOURCE POTENTIAL

The future food demand and the importance of imports in the present food supply indicate the scope that could be available for import substitution in the agricultural sector. The agricultural resource potential of the island is the major factor that determines to what extent and for what products this demand can be met by local production.

Agricultural resource potential is a very difficult concept to quantify. It depends not only on basic physical factors like topography, climate and soils, but changes with levels of technology and with scientific progress. The level of agricultural development is not only a function of the agricultural potential, but also involves consideration of human, institutional, and economic factors. "Ultimately it is the will of a government and its people to develop policies and mobilize its resources and energies which will determine how much of this potential can be realized." (45, p. 492).

The Physical Resources

Factors regarded as relevant to a discussion of agricultural resource potential are the physical factors on which the agricultural potential depends, and the land utilization pattern and level of production as a reflection of the use made of the agricultural potential within the historical, economic, and political context. The potential can be evaluated by contrasting the present levels of productivity with possible levels of production. The feasibility of improving the present situation in the light of problems associated with further development will be considered.

Mauritius is entirely volcanic in origin, being the worn-down summit of an immense shield volcano which was built up from the ocean bed in Cretaceous times. The central plateau, about 1,800 feet in altitude, is encircled by rocky precipitous peaks. It falls abruptly on the south and west to a narrow coastal plain, but slopes gently to an undulating plain in the north. In the southwest corner of the island, the plateau is strongly dissected and eroded, as are also the southern slopes of the mountain ranges in the south. The rivers are deeply incised in the gently rolling topography of the younger volcanic series, and in the extremely rocky areas of the late lavas there is almost no surface drainage. About 14 percent of the areas with slopes between 11° and 20° , where the rainfall is adequate, have already been cultivated.

Lying within the tropics, isolated in the southeast Indian Ocean, this small, relatively low island has a climate which is maritime tropical in summer and sub-tropical in winter. The central plateau and mountains lie in the path of the humid prevailing winds. This results in the climatic division of windward, transitional and leeward zones, within which topography, exposure and distance from the sea cause variations resulting in micro-climatic regions. There are no great variations in the temperature. The mean annual temperature ranges from 23°C . on the lowlands to 20°C . on the plateaus. The island lies in the path of the Southeast Trade winds for most of the year. The low-lands have a hot rainy season and a cool dry season with occasional showers, and the uplands have a warm rainy season, a cool damp season with relief rains, and a relatively mild dry season. Rainfall varies from 50 inches in the east at sea level, up to 175 inches in the plateau. The variations in the annual rainfall may be considerable from year to year and departures of 50 percent from the mean are not uncommon.

The island is sometimes in the path of tropical cyclones in summer. The strong gusty winds and torrential rains associated with these depressions are disastrous to all crops. The probability of cyclone occurrences over short periods of years is erratic. In each 25 years there has been average of 7 cyclones of considerable intensity and 15 of lower intensity (8). Cyclones are in part responsible for the monoculture of Mauritius. The two main crops, sugar cane and tea, suffer only temporary setbacks and need no new investments to get back into production. Other crops, especially tree crops, may be completely ruined.

Land Use

A survey of land use made in 1965 showed that in 1965, 55.5 percent of the land was cultivated and 36 percent was not cultivated and under forest, scrub or grasslands. The remaining 8.5 percent which is not cultivable consists of mountainous rock outcrops, roads, built-up areas and reservoirs.

Improvement of Potential of Uncultivated Land

To bring into cultivation in the future presently untilled lands and to obtain maximum yields from presently arable land, one must choose carefully the varieties of crops which can be grown to the land which suits them. (The requirements and potential of each of these crops will be evaluated systematically.) In some cases, land will have to be reclaimed by drainage or destoning and in other cases irrigation offers the most promising approach to realizing Mauritius' agricultural potential.

The irrigation pattern and requirements for the island were analyzed and evaluated by the FAO/UNDP Land and Water Resources Survey Project. Of the 36,100 acres irrigated, about 75 percent needed improved irrigation practices to improve efficiency or prevent waste of water. Another 40,000 acres needed irrigation water either to be brought under cultivation or to improve yields and intensiveness of agriculture. These irrigation projects, especially in the Northern Plain, are likely to be very expensive because of the scarcity of water sources in the area.

In regions like Plaines Wilhems and the Eastern and Southern Regions, the cost of developmental works would not be excessive, but on the other hand the increase in productivity will also not be very great. The use of overhead irrigation in lieu of surface irrigation has been recommended particularly for the porous soils (19).

Surveys of the ground water and surface water potential of the island and of most economic ways of supplying the water needs have been made (16, 17). Feasibility surveys have already been carried out for many of the irrigation projects; the major problem is the cost involved (15).

Provision of irrigation water would allow intensification of agriculture and optimum use of land resources in those subhumid areas of the North and West where other crops cannot be grown in the dry season or are grown under conditions of uncertainty due to unreliability of the rainfall. As sugar cane needs a dry season for maturing and other crops need adequate water for proper growth and optimum yields, irrigation is an important consideration.

Irrigation schemes were also prepared in the Land Water Resources Survey. In the Northern Plain, the irrigation project would allow irrigation of 16,920 acres on an "all cane" scheme or 13,955 acres on a "diversified scheme." The irrigation project for the Western Coastal Region is for 11,590 acres sugar cane, 930 acres paddy rice and 4,774 acres food crops. The additional profits from the two schemes are estimated at about Rs 3,320,000 for the Northern Plain and Rs 1,960,000 for the Western Coastal Region (18).

Cultivated Land

In 1965, the arable land in Mauritius occupied 245,000 arpents, slightly more than half of the island. Ninety-five percent of the cultivated land was under sugar cane, 3 percent under tea, the second most important crop, and only 2 percent of the arable land was left for all other crops. There seems to be scope for increased production of most of these other crops to satisfy the island's consumption demands and/or to diversify exports. Expanded output of a number of commodities would probably provide employment opportunities and optimize the land use pattern, while not necessarily hurting the country's balance of payments situation.

Sugar Cane

The effective area under sugar cane seems to have stabilized around 205,000 arpents in the last 6 years. The average yield in good weather years now exceeds 30 tons of cane and 3.2 tons of sugar per arpent. Figure 13 illustrates the evolution of the sugar industry in Mauritius.

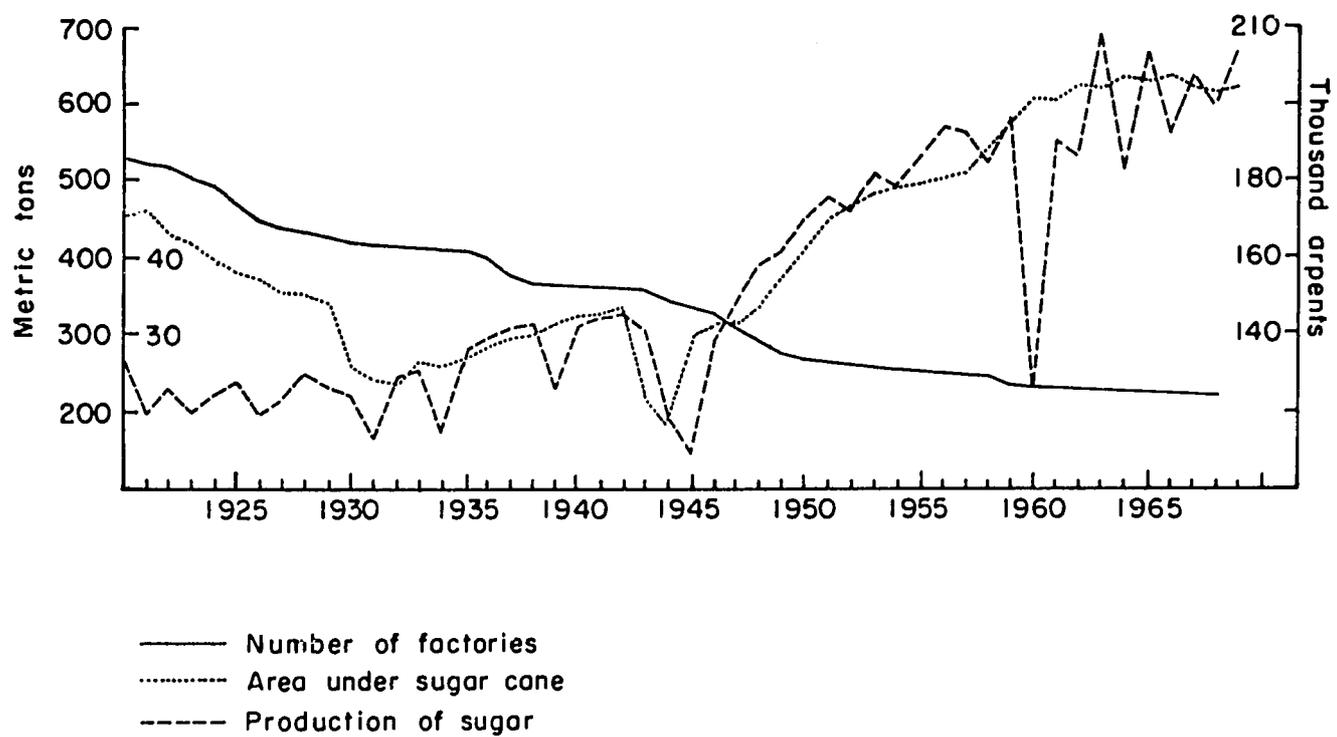
At the beginning of the 19th century when there were 60 sugar factories at work the colony produced 3,000 tons of sugar and 30,000 gallons of rum from cultivated sugar cane on an area of 10,000 arpents. A peak of 172,000 arpents in sugar cane was reached in 1921. The decline thereafter was mainly due to diseases and pests affecting the crop, as well as malaria, which had an effect on production. During the depression years it reached a low of 128,000 arpents. Since then both area and yields have increased steadily as a result of disease resistant and higher yielding varieties, developed by the island's Sugar Cane Research Station. Factors beyond control which have deterred this development are war and cyclones. During World War II, for instance, shortage of imported foods led to retirement of some land from sugar cane. Disastrous cyclones in 1944 and 1945 seriously affected sugar crop yields.

By 1960 the cultivated area had risen to more than 200,000 arpents. That year saw the average island yield of about 26 tons of sugar cane per arpent reduced by more than 50 percent by one of the worst cyclones of the island's history.

Sugar cane is grown in all parts of the island, although the yield is affected by climatic conditions. The yields of cane are lower in the subhumid regions without irrigation which have rainfall deficits during the growing season, and in the super-humid regions where there is rainfall surplus during the maturation period.

Most of the soils under sugar cane have very good physical condition and a very good absorption resulting in very slight erosion during the torrential summer rains,

FIGURE 24. MAURITIUS : EVOLUTION OF THE SUGAR INDUSTRY
1920 TO 1969



Based on data in Mauritius Chamber of Agriculture, The Presidents Reports

and can be cultivated almost immediately after rain. The type of soil and ability to supply plant nutrients seem to play a secondary role in sugar cane production, as long as the soil is sufficiently permeable to retain water, allow cultivation and root penetration. The lack of nutrients can be made up by the application of the proper fertilizers.

Technological progress enabled the cultivation of sugar to be extended to areas which would otherwise have been left uncultivated such as steep slopes where there is adequate rainfall; land flooded by lava which was reclaimed by use of heavy mechanized equipment; and poor soils reclaimed through drainage and irrigation. This technological progress is largely due to the efficiency and successful organization of the sugar industry.

The sugar cane lands are cultivated by estates and owner planters. Twenty-two estates presently cultivate 53 percent of the area, while the remaining 47 percent is cultivated by some 28,000 owner planters. This ratio is exactly the reverse of the situation in the early '50's when the ratio of estates to planters' lands was 47 to 53. This trend is completely different from what has been taking place in the rest of the world where sugar cane lands are increasingly cultivated on holdings belonging to small farmers (25, p. 13).

The estates operate factories which also crush the canes of the owner planters, most of whom cultivate plots of less than 5 arpents. Only a small number of them cultivate plots of more than 50 arpents. There are also about 2,000 tenant planters who cultivate land rented from estates or large planters.

The industry is efficient and well organized (35, p. 79; 2, p. 40) due to the efforts of the Mauritius Sugar Industry Research Institute. Research regarding cane breeding, entomology, cane pathology, irrigation and sugar manufacture has placed Mauritius in the forefront of knowledge in this industry. The new varieties of cane evolved to suit the various humidity zones, to resist winds and diseases have resulted in an increase of the area under cane, as well as higher production of canes and sugar. Total island production has out-stripped all forecasts. It exceeded 685,000 tons of sugar in 1963. An estimated output of 750,000 tons could be reached in the next few years, if the present trend is followed.

The complicated requirements of the ecology of the island make sugar the most suitable crop, and the development of this monocrop economy cannot be attributed to luck alone. The sugar cane is a crop to which the damage by cyclones is temporary, and the plantation needs no new investment as would be the case with most other crops. In 1945 and 1960 when Mauritius experienced the worst cyclones, about 50 percent of the average crop could be exported, while all other crops were devastated and suffered severe setbacks.

The sugar industry is the biggest employer in Mauritius, providing work for about 40 percent of the economically active population. The employment level in the industry has remained stationary over the years, at between 50,000 and 60,000 since 1890, while production has more than trebled. The future prospect for employment opportunities in that sector of agriculture is therefore bleak. During the intercrop season one-eighth of the labor force is laid off. The industry presently employs far more workers than it would if it were allowed to be run solely on an economic efficiency

basis. The use of weed killers instead of manual labor for weeding, the rationalization of the industry by centralization of the factories, bulk handling of sugar, and greater use of mechanized equipment would improve the efficiency of the industry but would result in higher unemployment.

Sugar is by far the major contributor to the balance of trade. It is therefore relevant to investigate the possible improvement of the potential of land under sugar cane. The possibilities of improvement depend on the extent to which current yields of sugar can be increased. If sugar is going to remain the major future export crop, the intensive cultivation of sugar lands by use of interlines for other crops could contribute to the balance of payments by facilitating import substitution. The island average yields could be raised by improvement of the cultivation techniques and levels of input of the small farmers.

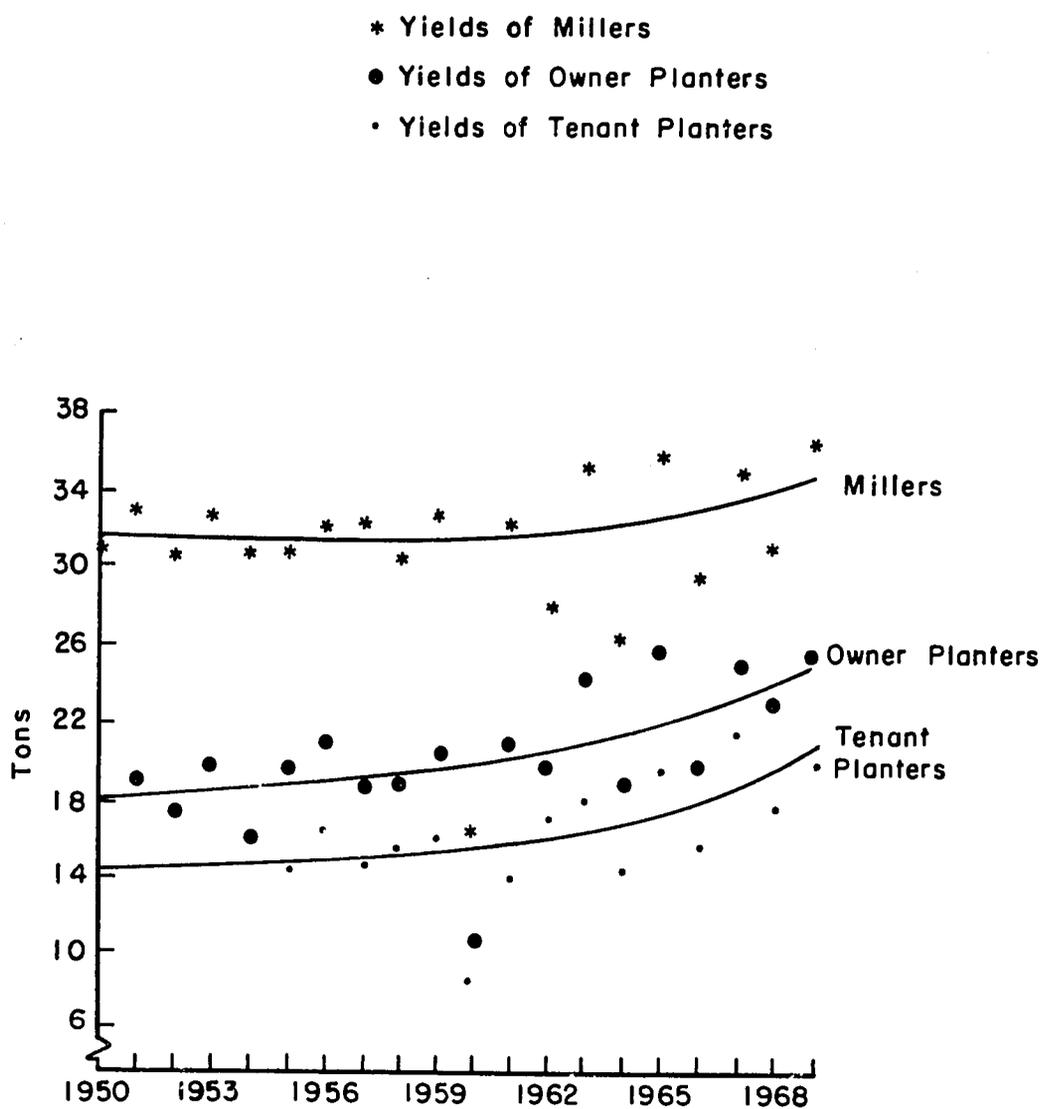
There is still considerable difference between the yields from plantations of the millers and those of owner planters or tenant planters, although the gap has been decreasing (see Figure 14). The difference is mostly due to the methods of cultivation, lower inputs of fertilizers, and also because most of the small planters and especially tenant planters, have some of the less favored lands and lack irrigation water. Total production would increase by more than 10 percent without any increase in acreage if the yields of the owner planters were brought at par with those of the millers. Increasing the yields of the lands of the less efficient sugar cane farmers would release about 27,000 arpents for cultivation of other crops without any reduction in the production of sugar.

The land between sugar cane furrows is available for cultivation of certain crops during the months between the planting of the canes and the time they are high enough to shade the interlines. The effective area thus available for the crop is equivalent to about four-ninths of the cane area under virgin canes thus planted, in any given year. After the harvest, the land between the ratoon interlines of sugar cane can be used again for cultivation of quick growing crops. Generally only every second interline of ratoons is cultivated, the effective area in any given year amounting to about two-ninths of the gross area under such ratoons.

This intensive utilization of sugar cane land is not possible everywhere. The area and duration that the sugar cane land is available for cultivation of other crops between cane rotations are limited by the following factors: a) the length of rotation, b) the extent to which certain essential preplantation works, like wall building and destoning, have to be done, c) the adequacy of rainfall in the area, d) availability of irrigation water, e) availability of mechanical equipment for starting work immediately after the harvest, f) the timing of the cane plantations so that they get maximum benefit from summer rains.

Taking these factors into consideration it was estimated that, at present, the total net effective area for cultivation of other crops on sugar cane lands is equivalent to about 11 percent of the total. However, the land is available for only part of the year, when the interlines are not shaded by the canes. Table 14 gives a general idea of what the situation might have been in 1968.

FIGURE 25. MAURITIUS : YIELDS OF CANE 1950-1969, TONS PER ARPENT



Based on data in Mauritius Chamber of Agriculture, The President's Report 1969/70

Table 14. AREA AVAILABLE FOR OTHER CROPS IN CANE LANDS*

	Millers Lands	Planters Lands	Whole Island	Effective Area	Area Under Cane	Land Availability No. of Months	Period
	(thousand arpents)			(percent)			
Rotation	3.2	2.5	5.7	5.7	2.9	4-6	July-Dec.
Virgin Interlines	7.4	5.3	12.7	5.6	2.9	3-4	Jan.-Sept.
Ratoon Interlines	27.5	15.7	43.2	9.5	4.9	3	July-Sept.
TOTAL				20.8	10.7		

* Data from H. Koenig, R. Mamet and A. Lagesse, "Developpement des Cultures Vivrieres," Revue Agricole et Sucriere de l'Ile Maurice, Vol. 48, no. 3, 1969, p. 182.

The effective area available can be increased by better programming of equipment use and labor, improved destoning and rock piling system, irrigation, and improved cultivation practices.

All crops needed to satisfy the food demands in the island cannot, however, be produced only within the sugar cane lands. In those areas where sugar yields are not optimum, other crops may prove more profitable. Its efficient marketing infrastructure has been a major factor in establishing the supremacy of sugar cane. A crop which is now competing successfully with sugar cane because of its high foreign exchange value is tea, for which a marketing infrastructure has been developed.

Tea

Most of the tea plantations are found on the superhumid plateau where the climatic conditions are very favorable for the successful cultivation of tea. In 1969, there were about 8,000 arpents under tea, and production of manufactured tea reached 3,000 tons, an increase of nearly 40 percent over the preceding year. On the mature plantations, climatic conditions, improved treatment, better management and other factors were responsible for a 39.3 increase in leaf production. The average yields per equivalent arpent of full bearing tea has increased by more than 113 percent during the last five years from 1847 kilos of green leaf in 1964-65 to 3,949 kilos in 1969-70 (Table 15).

The soils are ideally suitable for tea growing. Much of the tea plantations lie on the Latosolic Brown Forest and Humic Ferruginous soils. The crop has established itself as the second commercial one of the island owing partly to its ability to recover from temporary damages caused by cyclones. The tea plantations are on sloping land, facilitating soil drainage essential for tea cultivation. The tea lands planted by government are leased as small holdings of about 2 to 5 arpents each. The pattern of ownership in the tea industry, consisting of large plantations attached to factories side by side with small units of production resembles that of the sugar industry. The structure of the industry is summarized in Table 16.

Table 15. PROGRESS OF TEA INDUSTRY AT VARIOUS DATES*

Year	Area Under Tea (arpents)	Production Manufactured Tea (thous. m. tons)	Tea Export Quantity (thous. m. tons)	Tea Export Value (m. rs.)
1949	2,000	0.3	-	0.1
1959	4,000	0.9	0.5	2.7
1965	6,600	1.7	1.1	5.9
1966	7,100	2.0	1.3	6.5
1967	7,900	2.2	1.6	8.4
1968	8,400	2.3	1.7	9.6
1969	8,400	3.2	2.7	14.6

* Data from Mauritius Central Statistical Office, Digest of Statistics, 1969.

Table 16. THE SIZE DISTRIBUTION OF TEA HOLDINGS, 1968*

Size Group (arpents)	Number of Plantations	Aggregate Area (arpents)	Percentage of Total Area
Less than 1	94	56.1	0.7
1 and less than 3	439	664.8	8.2
3 and less than 5	323	1,171.2	14.5
5 and less than 10	12	72.2	0.9
10 and less than 25	8	111.6	1.4
25 and less than 100	11	754.0	9.3
100 and less than 300	19	2,715.9	33.7
300 and less than 500	2	630.7	7.8
500 and over	2	1,896.2	23.5
All Size Groups	910	8,072.7	100.0

* Data from Mauritius, Tea Control Board, Statistical Review, 1968.

There has been a certain expansion of tea at the expense of sugar cane in the super-humid areas where yields of sugar are lower. A survey of the tea industry in 1961 showed that 45 percent of the tea planters owned cane lands also, although very few tea planters have their major interests in cane cultivation. On the plantations of small tea planters there was 4 times as great an area of tea as there was of sugar (23, p. 9).

A sugar cane plantation starts to pay back in 18 to 20 months, as against 3 to 5 years for tea; on the other hand, a tea plantation can last profitably for more than 50 years while the profitable ratoon life for sugar cane is about 10 years. Tea is a very labor intensive crop and necessitates about 1 man per arpent per year. It is also a crop with peak needs of labor like sugar cane, and fortunately these peak labor needs

do not coincide. Large planters with more than 5 arpents employed more than 4,000 persons in 1969, and there were about 900 small planters cultivating less than 5 arpents with the help of family labor and some hired labor.

Tea's contribution to the balance of payments has been rising very rapidly during the last few years. However, tea still represents only about 4 percent of the total exports even though tea exports have trebled in the last six years, increasing from one million kilos in 1963 to 2.7 million kilos in 1969 (Table 15), and the value of the exports has risen from 5 million rupees to 14 million rupees in the same period. Exports will continue to increase, as many of the tea plantations are still immature, and yields per arpent depend on the age of the plantation.

In June 1969 more than half of the tea plantations (4,080 arpents) were immature, i.e., less than eight years old, and of these about one-third were not yet in bearing. There were also 2,000 arpents of land already prepared for tea planting. The average yield of tea per arpent of equivalent full bearing varied in 1968-69 from 4,695 kilos per arpent to 2,164 kilos per arpent for the plantations attached to factories. The average yields for plantations attached to factories was 3,949 kilos per arpent, more than twice the average of the yields of small planters.

Production in the next decade can therefore be expected to increase very rapidly. This increase would be dramatic if the yields of small planters are increased at the same time to the level of those of the plantations attached to factories. The increase in yields as well as the expansion of tea lands at the expense of forest and scrublands and sugar cane will create more jobs, and if tea finds an expanding export market, it would be one of the most promising crops for the partial solution of the problems of the island.

Tea is the second major export crop, but for export diversification, the production of other crops has to be investigated. Since presently most of the food is imported and the demand for food in the future will be increasing, the production of other crops to satisfy the demand will lead to a decrease of the food import bill.

Other Crops

Other crops are cultivated simultaneously with sugar cane or during fallow periods, they are also grown in small plots within built-up areas, on lands unsuitable for sugar cane, and on mountain slopes. In the last case, this in some instances has led to soil erosion, and lands thus impoverished have been abandoned to scrub or planted back to sugar cane. Other crops traditionally have been grown on a very small scale by farmers or laborers who rent land from sugar estates or planters. Few producers except a few market gardeners rely on production of other crops as their main source of income, and few landowners, large or small, cultivate food crops. Only recently have sugar estates started cultivating crops other than sugar cane or tea.

In 1968 the area planted to food crops, mixed vegetables and creepers^{1/} during the year amounted to 9,224 arpents. The area under purestand cultivation is about 2,000 crop arpents per year. The purestand field crops grown between rotations of cane

1. Creeping cucurbit.

and the purestand equivalent of crops grown in interlines of virgin or ratoon canes account for about 7,500 crop arpents. The intercropping of virgin sugar cane and cultivation on fallow land between rotations of sugar cane have become standard practices in recent years. In 1966 the Mauritius Sugar Producers Association planted 1,650 arpents in full plantations and 3,680 arpents of interlines of maize, potatoes, beans, peanuts and miscellaneous crops (33, p. 65). An unknown number of small farmers especially in the northern plain region intercrop the virgin sugar cane on their land or on cane lands rented from estates. Food crops are more profitable if grown in interlines of sugar cane than in purestands.

For the land use surveys, all cultivated crops other than sugar cane and tea were grouped together because they could not be identified on the aerial photographs. They included vegetables, tomatoes, potatoes, maize, peanuts, ginger, tobacco, pineapples and root crops such as manioc, sweet potatoes and eddoes. Other crops occupied about 10 percent of the total cultivated area in 1949 and less than two percent in 1965.

The problem of producing enough food crops has been a persistent one in Mauritius and has attracted the attention of government on many occasions. The main attempts to increase food production, including subsidy payments, took place during the two world wars. The return to normal conditions and the availability of cheap imported food led to the return to sugar cane cultivation each time. The area under food crop cultivation peaked at 17,500 arpents in 1947-48. During World War II a government order required all sugar cane planters to grow food crops because imports were not available. The compulsory area allotments to food crop cultivation were stopped in 1945. From 1947 to 1949 a bonus payment scheme was put into operation. However, when subsidies were stopped in 1949, areas under food crops decreased immediately and imports increased to make up for the food deficits.

The average yield per arpent of the major crops cultivated in Mauritius is relatively low. It might be increased significantly if new varieties are used in conjunction with technological knowledge which in some cases is already available. There have been examples of rapid adoption of new methods where guaranteed markets were created, as in the case of potatoes and onions. The creation of the Agricultural Marketing Board in 1964 has stimulated the production of other crops such as potatoes, onions and garlic which suffered from lack of infrastructure compared with the sugar industry.

Potatoes: The production of potatoes, which are used as a vegetable in Mauritius, has increased very rapidly in the last eight years. Production was at about 4,000 tons in 1962 and had reached above 9,500 tons in 1968. This increase in production is due both to increase in the area under cultivation and increase in yields. The yield passed from an average of 4.6 tons per arpent in the early sixties to an average of seven tons per arpent in the late 60's. The Agricultural Marketing Board estimates that the potential yield of potatoes can be assumed to be 12 tons per arpent (31, p. 3). The crop is grown in purestand and in interlines of both virgin and ratoon canes, by small planters as well as sugar estates which find it a very profitable crop, since they grow it in the March to June season when they have ample slack work periods and can utilize available labor. The high guaranteed prices initially offered by the Marketing Board led to production exceeding the demand as well as the storage capacity available. The reduction in the minimum price discouraged many small producers but stimulated increases in yields resulting from adoption of improved methods of cultivation.

The annual consumption of potatoes is between 10,000 and 15,000 tons. The planting season extends from March to early September and consumption requirements may be met from June to February, when there is even a surplus for export at times. The rest of the year potatoes must be imported, since storage and production facilities are presently insufficient to satisfy consumption needs from January to May. Successful import substitution would require improved storage capacity and enhanced keeping qualities of the potatoes planted toward the end of the year. The scope for export is limited and depends on the ability of Mauritius to compete with other countries exporting potatoes. It depends also on marketing know-how and contact with foreign importers. The regularity of volume and quality of potatoes to be exported are also major factors.

Onions and Garlic: Besides potatoes, onions and garlic are the two other products handled by the Agricultural Marketing Board. Imports of these two products have decreased considerably since the Board started controlling them and offered guaranteed minimum prices.

Onion production by small farmers, mainly on the eastern coastal region and grouped in marketing cooperative societies, has increased rapidly in the past 5 years. Production reached almost 1,700 tons in 1969; the demand for onions averages about 2,500 tons a year.

The local crop comes onto the market mainly from July to October, while that of Rodrigues^{1/}, which is also under the control of the Board, comes from October to December. The rest of the demand is met by imports for the first 5 months of the year. The problem of onion storage has not been solved completely yet. There would be no difficulty in meeting the requirements for the island, if this storage problem were solved; the dilemma lies in the varieties of onions now grown. New high yielding types reach 7 to 10 tons per arpent, and yields of up to 14 tons per arpent may be obtained, but they have low storage life. The yield of the conventional variety of onion has better keeping quality, but is only 3.5 to 4.0 tons per arpent under ordinary conditions (30, p. 3).

Self-sufficiency in onions would help not only the balance of payments problem, but would contribute to increasing employment opportunities, since onion is a very labor intensive crop. If onions could be exported during the peak season, it would be helpful since production is higher than what can presently be consumed and stored, although there is a shortage by the beginning of each year.

However, in the case of garlic, production has been short of demand because the producer prices for garlic were unstable. Since the minimum guaranteed prices have been fixed by the Board, production has risen. But to meet the demand, some garlic still has to be imported. The yield of garlic is approximately 4 tons per arpent. It is a very profitable crop with a high labor input. Garlic also has some possibilities for export as indicated by the successful re-export in past years.

Ginger: Another spice which has had some success in the export field, without support of the Marketing Board, is ginger. This is largely due to availability of

1. Rodrigues, population 20,000, is a dependency of Mauritius, lying about 350 miles from Mauritius, and has an area of about 40 square miles.

export markets which do fluctuate considerably. Nevertheless, this has meant an average annual revenue of a half million rupees for the island in the recent past.

Ginger is grown mainly in the superhumid areas by producers who have a long tradition of ginger cultivation. The average yield is not very high, however, and production has fluctuated continuously over the years due to the instability of the export market. Production increased by almost a third to 1,500 tons in 1969 as a result of the establishment of a processing plant for dehydration. The returns to labor and to management are relatively low for the small farmers (18). Still, ginger is labor intensive and with increases in yield through improvements in cultivation techniques and vigorous export promotion, the industry could help in the export diversification process as well as raise the employment level.

Vegetables and Fruits: Mauritius is practically self-sufficient insofar as fresh vegetables are concerned, although in the case of fruits, imports reach as high as 2.5 million rupees a year. A wide variety of subtropical and temperate fruits and vegetables are produced in different seasons. The local prices are low at times as a result of competition and over-production, but may reach fantastic levels in times of cyclones. The production of fruits and vegetables is not organized and in the case of fruits there is practically no commercial production except for bananas and pineapples. Production of vegetables is labor intensive, the yields are satisfactory, and the returns to labor and management are high for the efficient market gardeners. No data are available, however, for fruits which suffer from the disadvantage of a serious fruitfly pest problem.

The major fruit imports are citrus fruits, apples and grapes, which can be produced locally although commercial cultivation is held up largely due to the fear of cyclone damage. Local production has been encouraged, and there has been an attempt at exports of fruits such as litchis and mangoes in recent years. Exports of bananas and pineapples prove a little more difficult because the varieties grown in Mauritius are not those preferred on the European markets and because such fruits have unusually high bulk relative to price.

The export market for fresh fruits and vegetables is limited, and there is considerable competition from countries nearer to the major European markets than Mauritius. Exports have started in recent years on a very modest scale taking advantage of the 5 regular weekly flights to Europe. Further development of such agricultural exports would prove of considerable advantage to the balance of trade, and could be a valuable supplement to policies aimed at decreasing food imports by stimulating greater local production of citrus fruits, apples, and grapes, which constitute the main fruit imports.

Rice: During the period of shortage of food imports following World War II, rice was produced locally on about 2,000 arpent, but production stopped when cheap imports became available. Rice is the major food import of the country, amounting to some 40 million rupees in foreign exchange annually. Under government stimulus production was resumed in 1967, but the industry is still in its infancy, with a production of less than 1,000 tons of paddy in 1969.

The average island yields are low, about 1.7 tons paddy per arpent. Rice is labor intensive, and the returns to management are negative, while the returns to labor and

management are relatively high, about Rs 150 per arpent per month, which is much higher than sugar.

Fairly good and consistent yields of 2 to 3 tons of paddy per arpent have been obtained in trials with imported varieties, and 2 crops a year with equally good yields in both seasons can be obtained (32, p. 29). The FAO/UNDP expert carried out experiments with overhead irrigated, direct sown rice and considered that particular attention should be paid to that method of cultivation which is very promising. If carried out on the available sugar cane fallow lands; this could greatly reduce the quantity of rice imported (18, p. 8). Government has taken different measures to encourage production, as the import substitution of rice would help to bridge the balance of trade gap as well as help to absorb more labor. This would mean the utilization of 6 million man days in the case of complete import substitution.

Peanuts: Although peanuts have been grown for a long time in Mauritius, peanuts as well as products obtainable from them, i.e., edible oil and oil seed cake, have always been imported. The imports of edible oil represent about one-tenth of the total food imports.

Peanuts can be cultivated in all parts of the island and are grown in rotation with other crops as well as in sugar cane interlines. About 80 percent of the peanut consumption is produced locally, mainly for nuts. The yields of the "cabri" variety peanuts which are usually grown are low, averaging only about 1.3 tons green weight per arpent. The returns to labor and management are therefore low for both small and large farmers. The crop has been grown mainly as a dry season crop since it resists drought tolerably well.

In the last few years, however, the drive for import substitution has stimulated interest in the production of peanuts for oil. This interest has been further increased by the establishment of an edible oil processing plant which refines imported oil for export and will also be able to extract oil from local peanuts if they are produced in sufficient quantities. Trials carried out by the Mauritius Sugar Industry Research Institute have shown that yields of up to 2.6 tons green weight and 1.2 tons dry seed per arpent may be obtained for the local variety, and yields about a third higher for "Virginia Bunch" variety already grown on a small scale. For varieties suitable for oil, yields of about a half ton of oil per arpent were obtained in the humid and sub-humid regions and of about three-quarter ton for subhumid irrigated areas (34).

Peanuts is not very labor intensive, but grown on a large scale to meet the present high demands for oil, it could help to save some 12 million rupees worth of imports besides providing some 2,000 jobs a year. Another important aspect would be the boost that the by-product, oil seed cake, would give to the livestock industry which presently depends on imports for concentrates.

Maize: Maize is not a staple food in Mauritius, but was consumed during the food shortage period after World War II; its cultivation was subsidized and reached 10,000 arpents. The maize acreage has averaged 500 arpents in the last few years, and production represented less than one-tenth of local needs for the livestock industry.

The crop can be grown best in the humid and irrigated subhumid regions. A large part is grown in the interlines of sugar cane, although recent experiments have shown

the maize then has a depressing effect on sugar cane yields (32, p. 18). The labor input is not very high, and the returns to management in the Western Coastal region are relatively high, while gross returns are not very high (18). The maize yield could be raised by improving the cultivation techniques, level and quality of the inputs. Yields of 1.8 tons of air dry grain per arpent have been obtained in experimental stations. Maize seems well suited to be an import substitution crop although the total imports saved and employment created would not be high. The local production of maize could make use of sugar cane lands and would help considerably to develop the livestock industry.

Meat and Dairy Products

At the last livestock census in 1964 there were in Mauritius some 42,000 dairy cows, 3,700 other cattle, 350 sheep, 66,000 goats and 3,000 pigs. Presently there are some 22,000 cowkeepers, more than three-fourths of whom have less than 4 cows. The animals are stall fed, the fodder being collected free by the family from woodlands and scrublands, and consisting of cane tops during the sugar cane harvesting season. Very little is spent on concentrates.

The average production per cow is 3 liters per day over 365 days, inclusive of milk fed to calves. The annual milk production is about 21,000 tons. The dairy industry^{1/} does not make much direct use of land resources, but contributes importantly to the milk supply, about half of the country's requirements. Although the returns to labor and management are very low, cowkeeping brings a much needed supplementary income to the cowkeepers who are mostly laborers with seasonal unemployment.

The grazing lands for beef cattle are mostly on the limited areas of the "pas geometriques." The yield is barely 150 kilos of meat per arpent. Herd cattle account for less than a tenth of the weight of locally slaughtered cattle, another half consisting of the cows of small producers.

The potential for the development of the beef and dairy industry is not high because of limiting factors such as the scarcity of land, the relatively high temperatures, inadequate and unreliable rainfall in the subhumid region, and the existence of the stomoxys fly which irritates the animals when outdoors. Land resources for the development of the meat and milk industry to substitute for imports could come partly from cultivated as well as from uncultivated areas. The "pas geometriques" presently in use is limited in area and will be increasingly devoted to the establishment of seaside bungalows and settlement with the development of the tourist industry, and hence will not be available for cattle grazing. However, lands on the superhumid plateau which are marginal for sugar cane may be profitably released for cattle rearing simultaneously carried out with forest plantations, thus saving scarce arable land resources. It is estimated that there is a potential of some 60,000 arpents which could be devoted to cattle rearing. This represents about 90 percent of the 18,000 arpents under savannah grasslands and between a quarter to a half of the 148,000 arpents under scrub, woodlands, and forest (22).

1. A detailed description of the dairy industry is obtainable in: M. Milliken, "Dairying in Mauritius, A Socio-Economic Survey," La Revue Agricole et Sucriere de l'Ile Maurice, Vol. 47, no. 2, April-June, 1968.

The present production can also be increased by improved production techniques. This would imply supplementary feeding with concentrates which may be obtained from peanut oil seed cake and would result in higher milk yields and heavier carcasses. Yields of 10.5 tons of milk per arpent and of 3 tons of meat per arpent are within possible reach (22).

Development of the industry to achieve self-sufficiency would save some 25 million rupees of foreign exchange and create employment opportunities. An FAO project is presently investigating the milk and meat industry to recommend ways of increasing the milk and meat production of the island.

Besides cattle, goats are the most important form of livestock. Most of the 65,000 goats except for a few herds on the West coast are stall fed as a backyard industry with poor production techniques. Goat meat is much appreciated, especially by the Indo-Mauritian section of the population who do not consume beef. Production could be improved substantially by proper breeding and feeding methods. A start has been made in this direction by introduction of imported selected breeds, but more extension work in this field is required. The impact from a nutritional point of view of increased production would be substantial although the impact on the balance of payments and labor situation would be negligible.

The conditions in Mauritius are not suitable for commercial rearing of sheep, but pig rearing has developed very rapidly in the last 5 years. Import of pork is negligible and overproduction has to be checked because the demand is not very high, and export is presently out of the question for Mauritius. Poultry production has already reached the overproduction stage because the market is limited by the low purchasing power of the majority of the population, and since most of the feed and components of locally manufactured feed are imported, the cost of production is high.

The meat and dairy industry would develop more rapidly if parallel development of crops like maize and peanuts (for oil seed cake) take place as this would most probably bring down the cost of concentrates and feed for livestock. Export of meat and dairy products in a diversification drive is out of the question, but in the field of import substitution more than 29 million rupees could be saved annually. Table 17 gives an indication of the relative importance of the various items of the imports of meat and dairy products.

The Fishing Industry

Fishing ought to be an important industry in an island surrounded by sea, yet the imports of fish and fish products have averaged more than 5.5 million rupees over the past 5 years, about half of the total expenditure on fish and fish preparations. The annual consumption of fish in Mauritius has decreased slowly over the last 5 years and has averaged 6,600 tons of fresh fish equivalent annually in spite of the near tripling of annual catches on the high seas during the period. The consumption of fish is not restricted by religious observances, as is meat in some cases. However, the price of fish is high for the bulk of the population, but since the price elasticity of demand is not known, it is impossible to forecast the effect of price reductions on local consumption of fish. A rise in income would raise consumption slightly, since it is known that the income elasticity of demand for fish is 0.71 (37).

Table 17. VALUE OF IMPORTS OF MEAT AND DAIRY PRODUCTS,
1965-1969*

	1965	1966	1967	1968	1969
(thousand rupees)					
Live Animals Chiefly for Food	2,848	4,364	5,600	5,016	5,636
Cattle	2,474	3,857	5,012	4,529	5,209
Sheep and Lamb	267	320	291	219	152
Meat, Fresh, Chilled, or Frozen	4,338	4,012	3,833	3,927	3,253
Beef and Veal	1,588	987	979	1,157	878
Mutton and Lamb	1,104	1,338	1,652	1,282	1,574
Pork	92	23	7	5	26
Poultry	896	984	761	876	279
Other	658	680	433	606	495
Meat, Dried, Salted, Smoked, not Canned	519	361	428	497	461
Meat, Canned and Meat Preparations	1,428	1,643	1,776	1,728	1,795
Dairy Products	12,357	13,904	12,645	13,941	12,390
Milk and Cream, Evaporated, Condensed or Dried	7,318	9,048	7,702	8,887	8,025
Butter and Ghee	1,826	1,690	1,693	1,457	1,545
Cheese	896	931	1,117	1,049	935
Other Dairy Products	2,315	2,233	2,125	2,526	1,856
TOTAL Meat and Dairy Products	21,670	24,284	24,282	25,109	23,535

* Data from Mauritius Customs and Excise Department, Annual Reports, 1965 to 1969.

The development of fishing offers moderate prospects of saving imports, increasing income, improving nutritional standards, and, within limits, creating employment opportunities. The pelagic and demersal fisheries may be expanded to meet the future increased demands of the population, replace part of the imports (about a third), and earn foreign currency by using the experience of Japanese companies on the export market. The lagoon fisheries should be reduced to allow restocking, and the number of fishermen reduced to enable those remaining to earn a living. Oyster culture, crab farming, and fresh-water prawn raising should be developed commercially for specialized exports and for the tourist industry.

Summary

To obtain the maximum agricultural resource potential, land which is the limiting factor has to be utilized to the limit. This means intensive cultivation, proper programming of the crop rotation so that no land or part thereof remains idle. The climate allows a 12-month growing season. Some crops can be grown throughout the year, while others thrive best at certain seasons of the year. The crop sequence must be planned so as to make the most of agro-climatic factors while respecting basic agronomic principles.

Realizing the agricultural resource potential would help considerably to meet the major objectives of increasing employment and maximizing the balance of payments. This is essential to enable the import of capital goods needed to achieve modern economic growth. In order to evaluate the feasibility of maximum agricultural diversification, while full utilization is made of all available land resources, a linear programming model has been designed to facilitate decisions regarding crop choice, sequence and rotation.

AN OPTIMUM LAND ALLOCATION MODEL

The Linear Programming Model

The primary objective of the following analysis is to test the feasibility of import substitution and export diversification, and in addition to determine its effects on employment and the balance of payments in Mauritius. Agricultural commodities that can be produced on the island may be used to meet domestic consumption requirements or may be exported. Therefore, a linear programming model is developed to determine optimum patterns of production, exports, and imports within the island's land and labor constraints.

The linear programming procedure is chosen because applications to similar problems are well established in the literature. There are many examples of linear programming models designed to determine optimum patterns of agricultural production (10, 11, and 12). In general, the optimizing criterion is the maximization of profits or the minimization of costs of production and transportation. However, the location of production is not an important problem in a small country like Mauritius. Most of the location models are "static" in the sense that only a single time period is considered. This is a satisfactory framework for annual crops. However, crops which are not annuals have been included in a study by G. Dean and M. de Benedictis (9). The model determined development patterns through time for small land reform farms in southern Italy. The optimizing criterion was to maximize the present value of future returns over a 60-year period. The alternative choices were between annual crop combinations and orchard crops with inter-tilled crop activities. Restrictions were imposed to ensure some minimum diversification against the risk associated with yield and price variability.

The specification of an LP model represents a very simplified version of the complex world. In particular, no single optimizing criterion explicitly considers all important social and economic factors. However, the solutions can provide valuable insights for determining agricultural policy. In the case of Mauritius, overseas trade is a most important part of the economy, and it is essential when optimizing resource allocation to consider the effect on the balance of payments. The objective is therefore to make the best use of available land and labor resources by maximizing benefits from domestic consumption or export earnings. If profit maximization were used as the optimizing criterion, the linearity specification of the model would result in a solution implying that the production of relatively few crops was optimum. This extreme type of solution does not adequately reflect the diverse pattern of domestic consumption. For this reason, the domestic consumption levels of agricultural products are specified as constraints on the model. Consumption requirements may be

covered by local production as well as imports. The optimizing criterion is to maximize the net earnings from trade. This criterion implies that any surplus agricultural production capacity is used as effectively as possible to earn foreign currency. Hence, the model provides an optimum trade and production pattern that is consistent with a given consumption pattern.

The specific objectives of the model are to determine the optimum production and trade patterns for the years 1968, 1975, and 1980. For the year 1968, the parameters defining input-output relationships, consumption levels, export and import prices, labor and land constraints, are derived from data collected in Mauritius. For the years 1975 and 1980, the parameters are determined by modifying the 1968 parameters to reflect projected population growth and technical improvements of production practices.

Three land categories characterized by differences in agro-climate, soil and topography have been identified. The land categories are: a) unirrigated subhumid areas requiring irrigation for maximum production, b) humid regions and irrigated subhumid areas, and c) superhumid regions. Each type of land had the potential for producing a certain number of crops, although some crops can be grown on more than one type.

The labor force available for the agricultural sector is specified as the economically active population minus those employed in the non-agricultural sectors. The labor required during a 12-month period for the production of a crop or combination of crops for one arpent of land is determined from survey data for each region. The size of the labor force and the number of arpents in each of the three land categories are the resource constraints for the model.

Twenty-three agricultural commodities that can be produced domestically are identified. The average consumption level per year for 1965 to 1968 is used to make projections for 1975 and 1980. This places an additional 23 constraints on the model. Commodities such as wheat flour which cannot be produced domestically are not included in the model. Hence, certain additional expenses for importing food are implied.

The first solution obtained from the model indicated the export of vegetables, ginger and fruits replacing completely the export of sugar. The export markets for these commodities are limited under present conditions. Some expansion of the export of these commodities may be successful in the future, it was, however, considered unrealistic to allow unrestricted expansion of these commodities. Hence, export constraints are specified for 8 commodities. These additional constraints lead to solutions that are more realistic in view of the existing limitations on export diversification and import substitution.

The optimum solutions derived from the linear programming model are discussed first in terms of the pattern of trade and then in terms of land use. Shadow prices, determined in the dual solutions for the constraints, are presented to provide a basis for evaluating the solutions. A comparison of the optimum trade and land use patterns for 1968 with the observed patterns is made to serve as an additional guide for evaluation. Implications of these results for the formulation of agricultural policies are considered not only in terms of the specified objective function, maximizing the balance of payments, but also in terms of other important criteria such as employment.

Optimum solutions are determined under five different specifications:

- I. 1968
- II. 1975 (low technology)
- III. 1975 (high technology)
- IV. 1980 (with tea restrictions)
- V. 1980 (without tea restrictions)

The production coefficients, labor and consumption constraints and the export and import prices that actually prevailed in 1968 are used in the model to obtain solution I. For the other solutions, the export and import prices of 1969 are used. The labor and consumption constraints projected for 1975, low population projections are used for solutions II and III, those for 1980 high population projections are used for solutions IV and V. The production coefficients for 1968 representing present low level of technology are used in solution II while higher production coefficients assuming improved technology considered attainable by 1980 are used in the model for solutions III, IV and V. Land constraints for tea are used in the model for solutions II, III and IV.

Trade Results

The five optimum patterns of trade, summarized in Table 18, imply that import substitution and export specialization are compatible. The optimum patterns of trade indicate that it is possible to maintain sugar and tea as the major export crops. The main commodities are produced at a level to satisfy consumption requirements. In the case of some commodities they are produced at a higher level, thus leaving some surplus to diversify exports.

With the exception of seed potatoes which have to be imported, solutions I, II and IV have no food imports. In II, the major import expenses are to satisfy the consumption of oil, and in V for rice, beans and half of the oil. It should be remembered that other products such as wheat flour and mutton which cannot be produced locally are still imported. The level of imports of agricultural commodities that can be produced locally averaged 100 million rupees per year for 1965 to 1968.

The relative importance of these expenditures in the total bill for food imports was shown to be significant and likely to increase with the growth of population. The feasibility of expanding the domestic production of these commodities was suggested previously. In fact the three products -- rice, oil from peanuts, and dry beans -- that are still imported in either solutions II or V or both were found in the analysis of agricultural resource potential to be the most unremunerative. In general, all 5 solutions indicated that import substitution is feasible.

The solutions also show that it is possible to diversify exports without any drastic reduction in the export of the traditional foreign exchange earners, sugar and tea. However, this diversification is limited, and sugar and tea contribute more than 90 percent of the total value of exports in all solutions. It must be remembered that the continued importance of sugar and tea results partly from the constraints set on the exports of high value products such as vegetables, fruits and spices. Without the export constraints these products would almost completely displace sugar, but tea production would expand. In fact, in solution V sugar is replaced by tea as the major export, when constraint on tea production is removed.

Table 18. OBSERVED AND OPTIMUM PATTERNS OF TRADE
FOR 1968, 1975, 1980
(thousand rupees)

	Observed (1968)	Optimum Solutions				
		I (1968)	II (1975)	III (1975)	IV (1980)	V (1980)
Exports:						
Sugar and Molasses	331,489	231,079	279,452	325,621	294,093	178,688
Tea	9,635	41,748	27,126	59,377	85,701	499,878
Peanuts (oil, seed, cake)	Negl.	11,676	490	28,837	32,376	490
Vegetables and Fruits	91	1,148	4,083	4,083	4,083	4,083
Others (ginger, garlic, onions)	550	3,435	3,287	3,152	6,136	6,000
TOTAL	341,765	289,086	314,438	421,070	422,589	689,131
Imports:						
Peanuts (oil, cake)	15,230		14,535			9,211
Rice	56,375		-			71,946
Others	24,152	757	774	536	624	4,602
TOTAL	95,757	757	15,309	536	624	85,759
BALANCE OF TRADE	+ 246,008	+ 288,329	+299,129	+420,534	+ 421,965	+603,372

The future outlook for sugar and tea prices on the world market was analyzed earlier and the prospects for both are poor. This emphasizes the need to develop the real limits to exporting alternative crops.

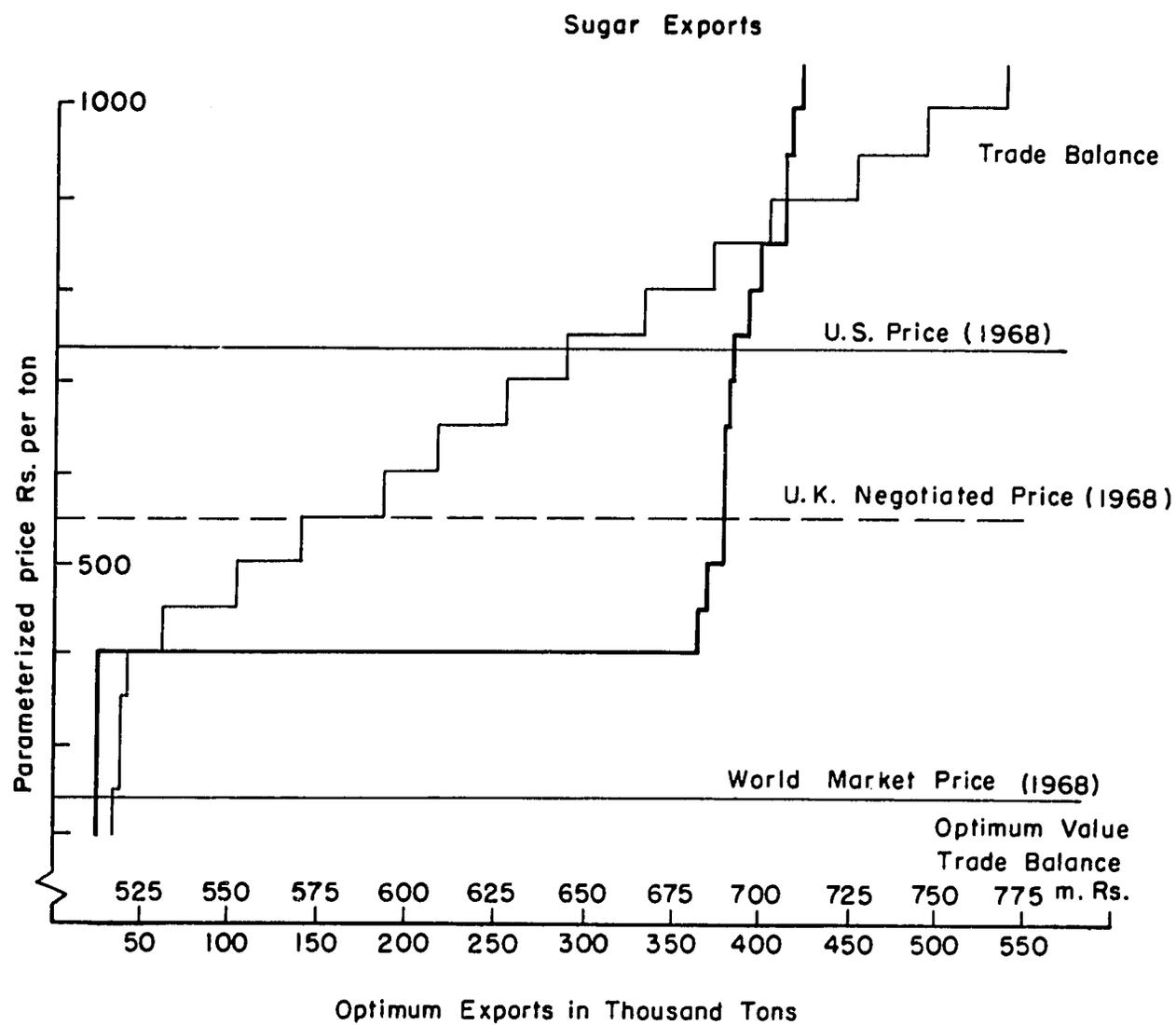
The balance of trade for solutions III and IV is more than 420 million rupees. This is about 40 percent higher than in solutions I and II. This is an indication of the impact of improved technology reflected by higher production coefficients and increased land area. Solution V has an even higher balance of trade of 603 million rupees in spite of the higher level of imports. This reflects the tremendous expansion of tea exports, assuming, however, that the price of tea is maintained at Rs 5,688 per ton.

Alternative Sugar Prices

Since sugar exports play an important part in all solutions, an additional analysis is conducted to determine the effect of changes in the export price of sugar on the solution for 1980 (solution V). This analysis indicates the optimum quantity of sugar exported at different prices, and determines therefore, a supply curve for sugar.

The range of export prices considered is from Rs 200 to Rs 1,000 per ton at Rs 50 intervals. The stepped export supply curve and the net trade balance are illustrated in Figure 15. To facilitate discussion of the results, actual prices in 1968 for Mauritian sugar in the major markets are shown. When the specified price is below 350 rupees per ton, the optimum level of sugar export is less than 30,000 tons. The largest increase in sugar exports occurs between Rs 400 and Rs 450 per ton. Above Rs 400 per ton the elasticity of supply is low. Doubling the price leads only to a 10 percent increase in exports.

FIGURE 29. MAURITIUS: OPTIMUM AGRICULTURAL TRADE BALANCE AND SUGAR EXPORTS AT DIFFERENT EXPORT PRICES



It may be inferred that the price has to be at least Rs 400 per ton if sugar is to remain a dominant export crop. At the U.K. negotiated price of Rs 552 per ton in 1968, the optimum level of exports is 375,000 tons. In 1968 the negotiated price quota from the U.K. was 380,000 tons, and the U.S. quota was 15,000 tons.^{1/} The importance of the Commonwealth Sugar Agreement to the position of sugar in Mauritius is obvious.

In Figure 15, the balance of payments increases only slightly as the price of sugar increases up to Rs 400 per ton. Above this price, the balance of payments increases steadily. Even though sugar exports increase from 24,000 to 363,000 tons at Rs 400, the balance of payments increases only from 521 million rupees to 534 million rupees. This is due to a reduction in the exports of other crops. Tea exports are more or less constant for the whole range of sugar prices, but the production of peanuts, rice, maize, and beans is gradually reduced as the price of sugar increases. In conclusion the analysis shows that increases in sugar prices above Rs 400 increase the balance of payments but cause only slight modifications to the land use pattern. A major reason for this result is that the exports of other more valuable crops such as vegetables, fruits, and spices are restricted in the model. Hence, export substitutes for sugar are limited.

Land Use Results

The optimum patterns of land use reflect both the trade patterns and the consumption requirements. Optimum land use patterns are summarized in Table 19 for the five solutions. Sugar cane remains the major crop representing more than 60 percent of the cultivated area in all solutions except V. In solution V the area drops to 44 percent of the total and that under tea increases to 49 percent. The area under sugar cane is highest in II and IV. In these solutions tea is restricted to 14,000 arpents.

Peanut production is at a comparatively high level except in II and V, and, as mentioned before, peanut oil is imported in these two solutions. Peanuts are to a large extent grown in the interlines of virgin sugar cane. In II the lower technology coefficients relative to III result in more land being used to satisfy other consumption needs. In V the lower peanut area reflects the increased tea area and the associated reduction of cane land available for peanut cultivation.

Production of rice to meet the consumption needs is maintained throughout all the solutions except when tea production is unrestricted in V. All other crops are cultivated to the level at which both consumption requirements and export constraints are satisfied. The only exception is in V when beans are imported.

The total area of all crops in each solution is greater than the actual amount of arable land on the island. This is due to the fact that full use is made of the cultivation of other crops with sugar cane during the rotation, and also that land can produce more than one crop per year.

^{1/} The sugar price specified in V is Rs 558 which implicitly assumes that the U.K. negotiated price is maintained.

Table 19. OBSERVED AND OPTIMUM LAND USE PATTERNS,
1968, 1975, 1980
(arpents)

	Observed (1968)	Optimum Solutions				
		I (1968)	II (1975)	III (1975)	IV (1980)	V (1980)
Sugar Cane	203,015	141,466	171,300	172,180	157,460	101,445
Tea	8,073	20,642	14,000	14,000	20,000	112,290
Rice	75	36,706	43,638	35,839	42,064	769
Peanuts	314	50,274	6,776	44,376	49,861	10,184
Pasture (beef, milk)	250	5,664	6,415	6,415	7,531	7,489
Fruits	1,229	2,043	2,449	2,298	2,737	2,637
Vegetables	5,876	6,229	5,872	4,302	4,885	6,458
Spices (ginger, garlic, onions)	486	1,989	2,163	1,658	2,204	2,121
Others (maize, beans, tobacco, root crops)	2,144	9,490	22,603	25,044	23,062	4,457
Total	221,464	274,503	275,216	306,112	309,804	247,850
Arable Land	214,717	214,717	214,717	229,510	229,510	229,510
Crop Area as a Percent of Arable Land	103	128	128	133	134	107

Evaluation of Solutions

All linear programming solutions are sensitive to the specified values of parameters, and in particular, the levels of constraints determine to a large extent the optimum pattern. For example export constraints were introduced to restrict the quantities exported to realistic levels for commodities that do not have well developed foreign markets. Shadow prices were computed for all constraints to help evaluate the relative importance of the constraints and to provide additional information for developing agricultural policies for Mauritius. In our model, the shadow price measures by how much the trade balance is increased if a constraint is relaxed by one unit.^{1/} Shadow prices for all constraints are summarized in Tables 20 to 24.

If one of the consumption constraints is reduced, the "surplus" production could be used to reduce imports, expand exports, or alternatively, resources that are used to produce the surplus could be diverted to other crops. A comparison of the shadow prices with export and import prices show which of these alternatives apply. Computed shadow prices per ton are given in Table 20 for the five solutions.

a) When the shadow price is less than export price; the exports of that commodity are already at a maximum and the resources would be used for other crops. Products

1. It must be remembered that the sensitivity of the shadow prices to large changes in the constraints cannot be determined without further analysis.

in this category are: peanuts, potatoes, vegetables, bananas, other fruits, ginger and garlic for all solutions; onions and tea in solutions II, III and IV; and pineapples in all solutions but V.

Table 20. SHADOW PRICES FOR CONSUMPTION CONSTRAINTS
(Rs. per ton)

Commodities	1968 I	1975 II	1975 III	1980 IV	1980 V
Sugar ^{b/}	249	558	558	558	558
Molasses ^{b/}	70	80	80	80	80
Tea ^{a/*}	5,634 ^{b/}	4,569	2,490	2,490	5,638 ^{b/}
Rice ^{c/}	670	456	433	433	846
Peanuts					
Nuts ^{a/}	792	820	360	360	550
Oil ^{b/*}	1,390	1,187 ^{d/}	1,150	1,150	1,187 ^{d/}
Cake ^{b/}	350	545 ^{d/}	362	362	494 ^{c/}
Vegetables					
Potatoes ^{a/}	160	66	254	254	141
Mixed ^{a/}	62	86	79	79	161
Fruits					
Bananas ^{a/}	64	184	196	196	212
Pineapples ^{a/*}	201	358	393	393	509 ^{c/}
Other ^{a/}	197	702	714	714	732
Spices					
Onion ^{a/}	339 ^{c/}	221	173	173	291 ^{c/}
Ginger ^{a/}	240	172	154	154	304
Garlic ^{a/}	201	250	231	231	449
Animal Products					
Beef ^{c/}	795	1,862	1,752	1,752	1,969
Milk ^{c/}	151	184	194	194	293
Others					
Maize ^{c/*}	87	28	28	28	329 ^{d/}
Beans and Peas ^{c/*}	154	320	320	320	985 ^{d/}
Tobacco ^{c/}	1,720	1,205	1,098	1,098	1,974
Tomatoes	156	128	97	97	254
Root Crops	49	188	218	218	178

a/ Shadow price less than export price.

b/ Shadow price equal to export price.

c/ Shadow price greater than export price but less than import price.

d/ Shadow price greater than export price and equal to import price.

* Unless otherwise specified.

No symbols - comparison with export price not applicable.

b) Shadow price equals export price; the surplus is exported. Products in this category are sugar and molasses in all solutions, tea in solutions I and V and peanut oil and cake in solutions I, III and IV.

c) Shadow price is greater than export price but less than import price; exporting the commodity is not as profitable as exporting another crop, and consequently, resources are diverted to other crops. Products in this category are rice, maize, tobacco, beef and milk in all solutions except V.

d) Shadow price equals import price; the surplus is substituted for imports. Products in this category are; oil and peanut cake in solution II, and oil, beans and peas in solution V.

Crops in groups (a) and (b) may be considered for export potential and crops in (d) for import substitution. Crops in group (c) are produced domestically only to cover consumption requirements.

The shadow prices for export constraints shown in Table 21, indicate that fruits, vegetables, tea and garlic have the highest values in all solutions. These prices, however, are on a per ton basis and reflect existing differences in prices, an alternative comparison may be obtained by considering the shadow prices as a percentage of the respective export prices. This is equivalent to replacing the quantitative unit of comparison by monetary unit. Table 22 shows the increase of the trade balance if the export constraint is relaxed by 100 rupees. Fruits and vegetables make the highest contributions in all solutions. Ginger, garlic and potatoes have high values in solutions II, III and IV while bananas and pineapples have high values in solution V. The relative importance of potatoes using the Rs 100 units compared with the ton units reflects the bulkiness of this product. In contrast, tea which has high shadow prices per ton, has low values per Rs 100. The general conclusion is that export promotion policies should give priority to the markets for vegetables and fruits.

Table 21. SHADOW PRICES FOR EXPORT CONSTRAINT
(Rs. per ton)

Commodity	1968 I	1975 II	1975 III	1980 IV	1980 V
Tea	a/ 8	1,119	3,198	3,198	a/ 430
Peanuts	140	160	620	620	159
Potatoes	2,408	233	254	254	1,323
Vegetables	161	1,399	1,406	1,406	12
Bananas	499	41	29	29	0
Pineapples	4,360	42	7	7	0
Other Fruits	0	3,744	3,732	3,732	3,714
Onions	347	54	102	102	0
Ginger	518	428	445	445	296
Garlic		1,250	1,269	1,269	990

a/ Not restricted.

Table 22. SHADOW PRICES PER RS. 100 OF EXPORT CONSTRAINTS
(Rupees)

Commodity	1968 I	1975 II	1975 III	1980 IV	1980 V
Tea	a/	19.6	56.2	56.2	a/
Peanuts	1.0	16.3	63.2	63.2	43.8
Potatoes	46.6	77.6	84.6	84.6	53.0
Vegetables	90.8	94.2	94.6	94.6	89.0
Bananas	71.5	18.2	12.8	12.8	5.3
Pineapples	71.2	10.5	1.7	1.7	b/
Other Fruits	95.6	84.2	83.6	83.6	83.5
Onions	b/	19.6	37.0	37.0	b/
Ginger	59.1	71.3	74.1	74.1	49.3
Garlic	51.8	83.3	84.6	84.6	66.0

a/ Not restricted.

b/ Constraint not binding.

The shadow prices of the major resource constraint, land, are summarized in Table 23 for each of the three land categories. These shadow prices increase as consumption and population levels increase, and also with improved technology. In solution V the shadow price of land in the superhumid category is high compared with the other two categories. This is due to the suitability of the region for tea cultivation which is unrestricted in V. The shadow prices may be considered as imputed rents for the different land categories. Investment in irrigation is equivalent to moving land from the subhumid to the humid category. The increases of imputed rent per arpent due to irrigation in the five solutions are Rs 320, Rs 742, Rs 750, Rs 750, and Rs 741 respectively. In all solutions except I the increased value is higher than the cost of irrigation which is about Rs 500 per arpent.

Table 23. SHADOW PRICES OF LAND
(Rs. per arpent)

Regions	I	II	III	IV	V
Subhumid	101	1,318	1,525	1,525	1,013
Irrigated Subhumid and Humid	421	2,060	2,275	2,275	1,754
Superhumid	227	1,754	1,964	1,964	2,593

The shadow price of labor represents the imputed wages of labor, and is equal to zero if there is any unemployment. Table 24 summarizes the level of employment and the imputed daily wages for the five solutions.

In I and V there are no restrictions on tea production, which is labor intensive, and labor is fully employed. The imputed daily wages are Rs 7.59 and Rs 7.43 respectively.

These do not differ from the actual average daily wage which is very close to Rs 7.50, the minimum wage rate is Rs 5.00 per day. In all other solutions, there is some unemployment. The highest level is in IV reflecting the higher population. However, these levels of unemployment are low relative to existing rates. In III which is specified with a higher technology than II and an additional 15,000 arpents of land, 418,000 man-days are unutilized. As compared with 1,256,000 man-days in II. This points to the importance of increasing the arable acreage by clearing potentially cultivable land and providing irrigation. Solutions I and V imply full employment in agriculture is possible if tea production is expanded. Expansion of other labor intensive exports such as vegetables would give similar results. One should remember that the seasonal employment pattern of labor is not explicitly considered in the model. An expansion of the model to take this into account might be valuable.

Table 24. LEVEL OF EMPLOYMENT AND SHADOW PRICES OF LABOR

	Shadow Price	Number Employed	Number Unemployed
	(Rs. per day)	(000 man-days)	(000 man-days)
I	7.59	24,937	0
II	0	28,773	1,256
III	0	29,611	418
IV	0	31,586	6,725
V	7.43	38,311	0

The Results and Present Situation Compared

The optimum solutions indicate that sugar remains the major export crop of the island and tea the second in importance, although in solution V the value of tea exports exceeds that of sugar. Virtually all imported commodities climatically suited to this island can be grown in sufficient quantities to satisfy the consumption needs of the population, and a wide range of products is exported. The result is a higher agricultural balance of trade, and higher levels of employment in agriculture. It must be remembered that the expansion of crop alternatives to sugar and tea were artificially restricted to reflect export market limitations.

In order to determine the extent of the changes implied by the optimum solutions, a comparison is made with the existing pattern in 1968. The list of agricultural commodities actually imported in 1968 was quite varied. Of those imported items which could have been produced locally rice and oil were the most important. In all optimum solutions, sugar exports increase due mainly to an expansion of tea exports. Exports other than sugar and tea, which made up less than 2 percent of the total in 1968, remain at a low level of less than 10 percent because of the export constraints.

The balance of trade in all five solutions is higher than the actual level in 1968. In I and II, where a low technology is specified the balance of trade is only slightly higher than the 1968 level. In III and IV, where a high technology is specified, the balance of trade is almost double the 1968 level. The trade balance is even higher in V due to revenue from unrestricted tea exports.

Optimum land use patterns also differ from the existing pattern in 1968. The major differences, illustrated in Figure 16 are: a) a decrease in acreage of sugar cane and increase in area under tea; b) an increase in area of crops other than sugar and tea; and c) fuller utilization of sugar cane land for interline cultivation.

In all solutions but V, sugar remains the major crop, occupying more than 50 percent of the cultivated land. The actual sugar area accounted for 95 percent in 1968. Tea plantations covered 3 percent of the cultivated land in 1968, while the largest optimum area under tea, in solution V, is 30 percent. The contrast in the area of other crops between 5 percent observed in 1968 and 42 percent in IV suggests a need for agricultural diversification. The increased importance of other crops in the land use patterns relative to the trade pattern is due to the combined effect of import substitution and export diversification.

In 1968 the observed crop area was 3 percent more than the total cultivable land, while for all optimum solutions except V the crop areas are much higher. This reflects the increased intensity of land use during the sugar rotation through interline cultivation, and also double cropping in producing certain other crops such as rice. Crop-land as a percentage of available arable land used in the optimum solutions is summarized below:

	Observed	I	II	III	IV	V
Percentage	103	127	128	133	134	107

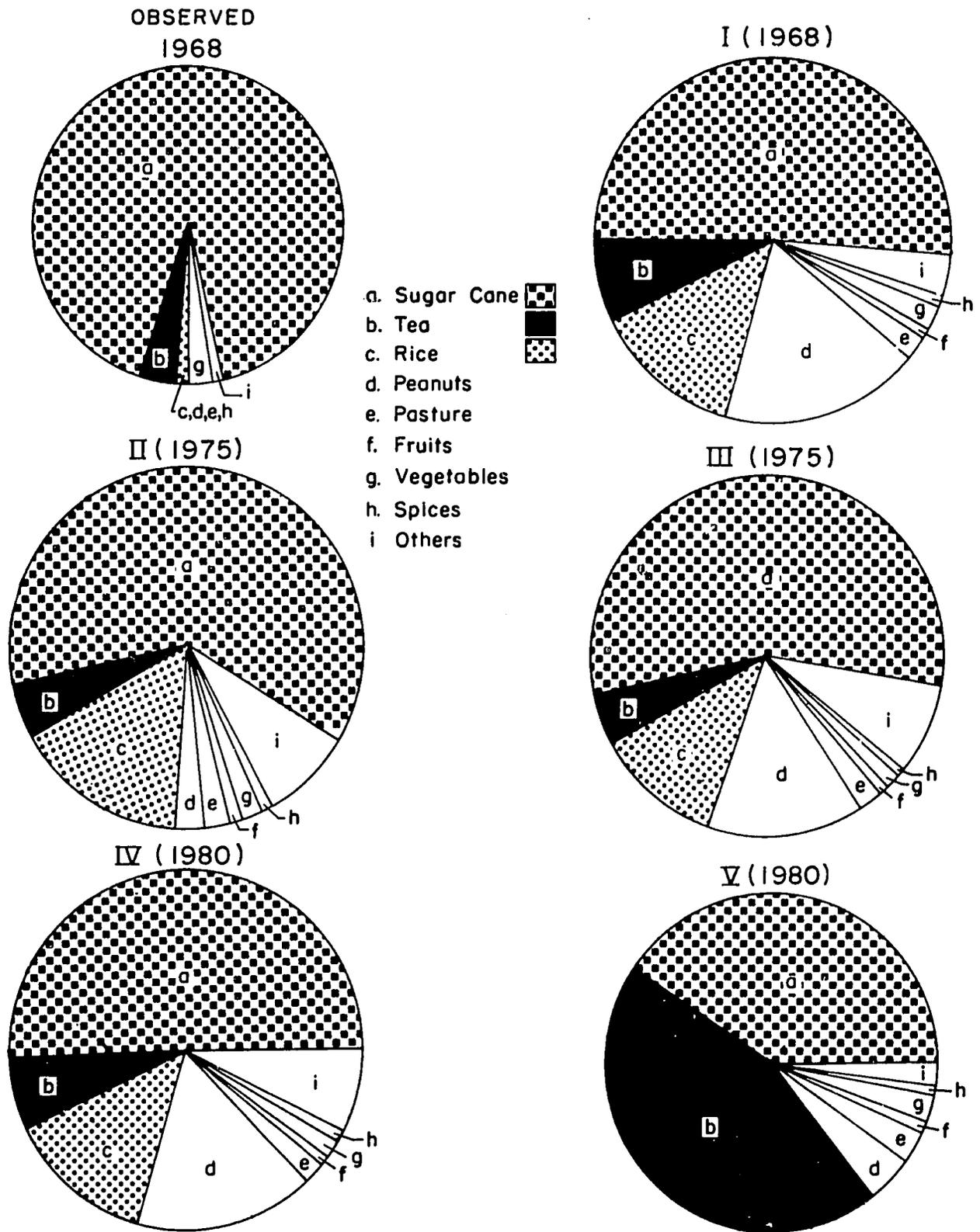
The lower value in V reflects the smaller sugar area and the corresponding reduction of interline cultivation. In evaluating the implications of the solutions other objectives besides the maximization of the balance of payments have to be taken into consideration. The following criteria will be used in the evaluation: a) the extent to which employment opportunities are created; b) the extent to which achievement of profit maximization is possible for the individual farmers; c) the degree of income distribution improvement; d) the increase in the total output of agriculture.

Employment opportunities are related to the labor requirements of the alternative crops, mainly garlic, vegetables and tea. For import substitution, the most labor intensive crops are rice and onions. However, the creation of employment opportunities as a criterion may not be consistent with profit maximization because of the existing minimum wage regulations.

Profit maximization depends on the cost of production and prices obtainable for the product. The data available on returns to production are based on the results of the FAO/UNDP survey of small farmers in the Northern Plain and Western Coastal Region (18). Those results relevant to our analysis are summarized in Table 25. The values are average yields of survey samples and the producer prices prevailing in 1967. These values are different from the average regional yields and from the prices in the overseas market used in the model.

Determining the relative profitability on the basis of returns to management per arpent per month for purestand food crops in the Northern Plain, we found most profitable crops are: tomatoes, onions, potatoes, tobacco, sweet potatoes, beans (green). The unprofitable crops are: manioc, peanuts, maize, mixed vegetables and ginger. In

FIGURE 31. OBSERVED AND OPTIMUM LAND USE PATTERNS



the case of the Western Coastal Region, garlic, potatoes, onions, tomatoes and beans are most profitable while maize, peanuts, mixed vegetables are profitable. For inter-lined crops, potatoes are most profitable, peanuts and beans are profitable and tomatoes unprofitable.

Table 25. MAURITIUS. COMPARISON OF RETURNS AND LABOR FOR SPECIFIC CROPS*

Crops		Gross Output	Returns to		Labor Input	Average Crop Cycle
			Labor and Management	Management		
		(rupees per arpent month)			(man-days per arpent month)	(months)
Sugar Cane	a	75	14	-8	4.4	12.0
	b	70	41	14	7.7	12.0
Peanuts	a	97	28	-20	9.6	4.7
	b	150	113	21	26.2	3.5
	c	161	111	19	15.5	3.5
	aI	135	68	23	8.9	4.1
Potatoes	a	575	215	83	26.3	3.2
	b	634	349	141	59.2	3.2
	aI	539	212	130	16.3	3.1
	cI	288	155	93	10.2	3.1
Mixed Vegetables	a	75	10	-31	8.1	6.5
	b	263	188	13	50.2	3.9
Onions	a	543	321	95	45.1	3.4
	b	717	478	130	99.4	3.2
Ginger	a	235	13	-59	14.4	9.1
Garlic	b	1,096	910	653	73.5	3.6
Maize	a	57	7	-21	5.7	4.9
	b	96	75	23	14.8	4.7
	c	76	59	18	7.6	4.7
Tobacco	a	240	139	43	20.2	6.9
Manioc	a	39	-3	-17	2.7	11.5
Rice ^{1/}		198	146	-43	38.3	4.3
Tomatoes	a	384	221	127	18.9	4.9
	b	350	285	129	44.4	3.5
	aI	101	-14	-126	22.5	4.0

a: Northern Plain

b: Western Coastal Region

c: Millers and large planters

I: Interline cultivation

* Based on data from FAO/UNDP Land and Water Resources Survey, Mauritius, Vol. VI, Agro-Economic Studies, Rome 1970.

^{1/} Harpal Singh, "Provisional Estimates of Cost of Production of Paddy," Ministry of Agriculture, Mauritius, unpublished mimeo.

In terms of returns to labor and management per man-day equivalent, onions, peanuts, mixed vegetables, ginger and manioc have returns which are lower than the minimum wages in the Western Coastal Region but much lower in the Northern Plain.

The case studies of "best" small farmers showed that the "best" farmers were able to achieve considerably higher returns than the average farmer in each area. Large farmers are interested in high returns to management. Rice, sugar, ginger, peanuts have negative returns to management for the small farmers. These results underestimate possible returns to management because of low yields. Sugar estates have high returns to management from sugar because of higher yields (36, p. 116). The yields of maize and peanuts on millers' and large planters' lands are about 26 percent higher on average than in small planters' enterprises. The labor expenses are 28 percent and 42 percent higher respectively. The net return to management for maize under millers' management is only 87 percent, for peanuts only 62 percent of that under small planters' management (18, p. 56). No data are available on costs of production of tea and fruits.

The differences in returns to management as compared with returns to labor indicate that agricultural policies should take into consideration relative profitability of the different crops for large and small farmers. By encouraging these crops, suggested by the optimum solutions, which are labor intensive and therefore suitable for production by small farmers, it may be possible to achieve a better distribution of income while satisfying other criteria under consideration.

Increased yields are technically feasible as high yields have already been achieved by individual "best" farmers in the island. The increased yields would depend on both increased non-farm inputs such as fertilizers, insecticides, pesticides, and irrigation water as well as improved technology and seeds. Data from the agro-economic survey of small planters (18) show that non-farm inputs are not used by all of the small farmers surveyed. Agricultural policies should therefore be formulated to bring about an increased use of "best" techniques. Increased yields can raise the balance of trade as shown by the difference between solutions III and IV.

POLICY IMPLICATIONS OF THE MODEL

Our analysis has shown that theoretically the problem of unemployment and balance of payments in Mauritius can be solved. The results of the LP model indicate full employment in the solution for 1968 (I), an agricultural unemployment of less than 2,000 persons for 1975 (III) and of less than 27,000 persons in 1980 (IV) and no unemployment in 1980 (V) if tea cultivation is allowed to expand. The agricultural balance of payments in all the solutions is much higher than under the current situation.

The agricultural development strategy which leads to these solutions implies both import substitution and export diversification. The results indicate that such a strategy is possible within the land and labor constraints of the island, and that it is compatible with the maintenance of traditional exports of sugar and tea.

The model represents a very simplified version of reality. The results should therefore be used with circumspection and should not be taken as a basis for precise planning. Nonetheless, certain general policy implications are indicated by the findings of the model and the solutions provide a starting point for considering adjustments in the land utilization pattern that can meet full employment objectives.

A critical assessment of the assumptions underlying the consumption, labor, land and export constraints helps to give better perspective to the discussion of policy implications. The consumption requirements and labor force are based on assumptions about the demographic future. The policy regarding population must ensure that the birth rate will not be higher than 25.5 per thousand in 1970-75, 22.4 in 1975-80, and 20.8 in 1980-85, and that the emigration rate does not fall below 3,000 a year as assumed in the projections. The Family Planning Campaign which has had remarkable success up to now most probably will be able to maintain the downward trend of birth rates. The age structure and number of economically active persons is affected directly by the level and type of emigration and any increase in the rate of emigration directly affects the labor market. Any improvement over the levels assumed will therefore help to make full employment a reality. Lowering of the rate of population increase will not only reduce the future labor force but will also reduce the consumption levels set as constraints in the model and liberate products for export and thus for contribution to the net balance of payments.

The consumption constraints used in the model were based on the average level and pattern of consumption for 1965 to 1968. Future changes in income were assumed to be minimal, but if earnings of the poorer groups rise significantly, the demand for products like meat, milk, and fruits will be higher.

Labor Constraints

The labor constraints were based on the assumption that the activity rates of the population will be the same as prevailed at 1962 census. This was low and may rise, especially if more women join the labor force. The labor force available to the agricultural sector is affected by the level of employment assumed in the industrial and service sectors. The labor constraint assumed that 3,000 new jobs will be created annually in the non-agricultural sector. There is already an active industrialization policy in the island. In the last two years 27 new industries have been started but the total number of jobs thereby created has been disappointingly low, less than 1,000. The recent legislation concerning industrial development and the creation of the "Free Zone" for export processing industries will most probably help to create more opportunities. Two months after the creation of the Mauritius exporting processing zone, five important industries have started operating. The number of jobs created has reached 500 and will probably increase as other industries are established. It remains, however, questionable whether the industrial sector will enable the target of 3,000 new non-agricultural jobs a year to be reached.

An implicit assumption by the model was that all who cannot find jobs outside of industry will be willing to work in agriculture. To be realistic, this assumption presupposes policies which will raise the social status of agricultural workers. The Young Farmers Movement which was successful in interesting school leavers to engage in agricultural pursuits, may serve as an example of what should be done in

this field. The Young Farmers were organized into clubs and producer groups, they were taught the necessary skills, provided with supervised credit and were helped with the marketing of their produce. They were made to feel their importance to the social and economic development of the country and to appreciate the economic advantages they could derive from agriculture. The press, radio and television were used to attract public attention to and enlist support for their efforts.

The full employment results of the model are based on labor intensive methods of cultivation presently in use. This has implications for policy about increase in efficiency and profitability through mechanization. Conflicts will arise, however, between the objective of increased employment and that of greater efficiency and competitiveness of export crops on world markets.

Labor intensive methods of cultivation may be encouraged by levying tariffs on imports of labor saving machinery, where its use is mainly to achieve higher profits or greater efficiency through the substitution of labor by capital.

Exception has to be made in the following cases where mechanization is essential: a) the maintenance of competitiveness on the export market as in the case of bulk sugar handling, b) the expansion of cultivated land as in the case of heavy machinery for clearing rocky lands or in the case of pumps and equipment for irrigation, c) the development of new agricultural industries as in the case of equipment for threshing, shelling and drying of products like maize, rice, peanuts.

The problem is very complex and no blanket legislation should be made regarding labor saving machinery. Each case should be examined separately, care being taken to minimize the delays due to bureaucratic red tape. An example of conflict is the case of weed killers, imports of which have been recently subjected to a 20 percent customs duty because of the adverse effect of their use on manpower required for manual weeding. The climatic conditions in the superhumid regions make hand weeding expensive and raise the cost of sugar production. When technological aspects of crop production, especially programming of rotation of crops are considered together with problems of labor efficiency and management, there seems to be a case for use of weed killers. Quantification of the alternatives and multiplier effects, should help in decision making between economic efficiency and employment.

Land Utilization

Full land utilization is implied by the results of the model. This indicates the need for policies to bring under cultivation those potentially cultivable areas presently unexploited and to encourage more intensive utilization of lands presently cultivated.

The policies presently in force for the Tea Development Scheme would be adequate for the superhumid lands. In the case of the subhumid regions, public investment in the Western Coastal Region Irrigation Project would be necessary to bring these lands under cultivation.

The creation of a land tax is a measure that would stimulate profitable utilization of land. Real estate taxes had been applicable to urban areas only until recently. They have now been extended to rural areas, but still apply only to immovable properties.

Once initiated, a land tax is easy to administer and may be structured and related to the land potential. The land capability survey of Mauritius is nearing completion and a cadastral survey has already been initiated. The data from these surveys are essential to serve as basis for the land tax. Presently all the sugar cane farmers have their lands registered with the Cyclone and Drought Insurance Board. All other farmers should be required to register and provide information quarterly about the crops they intend to produce and their expected harvests. This would enable production forecasts for market information and facilitate agricultural planning.

The flexible and appropriately graded taxation scale for land may be linked to the level of employment to encourage labor intensive crops and methods of cultivation and would act as incentive for fuller utilization of land. The tax being fixed would not discourage production and would stimulate adoption of yield-increasing cultural practices.

On balance, however, the sum of areas that can be brought under cultivation are relatively negligible. The increase in area under crops that will make possible import substitution and export diversification will have to come chiefly from more intensive exploitation of existing areas. These areas may be conveniently thought of as being:

- 1) the cane fallows between planting cycles and
- 2) the interlines of sugar cane on lands belonging to millers and large planters and
- 3) the land belonging to small farmers which would be transferred to the permanent and more intensive production of other crops.

The effective acreage that may be obtained for other crops by making full use of all sugar cane lands is about 21,000 arpents or about 11 percent of total cane area. The fuller utilization of the cultivated lands is best discussed in terms of the land ownership pattern. The millers and large planters should be encouraged to concentrate on sugar cane cultivation, while the small planters should be provided with incentives to switch to full production of other crops.

The results of the model indicate that a decrease in the area under sugar cane is necessary. This decrease should come from the lands of the small farmers which have lower yields. The decrease would thus have less effect on the total sugar production which may be maintained if yields are raised. The millers and larger planters have comparative advantage in cane production as their higher yields give them a higher marginal value for their sugar. The opportunity cost of the sugar estates of changing from sugar cane cultivation is higher than their average net returns from that cultivation, because of their low marginal costs in sugar milling. Furthermore the costs of food crop production for millers is higher than for small farmers.

Sugar Production

The policies concerning sugar production will have to be rationalized in line with world sugar market conditions. The institutional changes in the sugar industry based on the Commission of Inquiry into the sugar industry in 1962 (2) were largely to protect the small farmers' interests. If Britain joins the E.E.C., Mauritius sugar after 1974 will have to face the consequences of not having the Commonwealth Sugar Agreement on which to rely. The conditions about prices and quantities that Mauritius will

be able to sell Britain or the E.E.C. are still undecided. The prices obtainable in the E.E.C. and in the U.S. are higher than the negotiated price from the United Kingdom. The sugar industry and government will have to pursue efforts to secure better prices relentlessly.

Policies will also have to be implemented to enable a decrease in the cost of production of sugar to increase its competitiveness on the world market. Such policies will conflict with those about employing labor intensive instead of capital intensive methods of production. Bulk handling of sugar, concentration of milling in fewer, larger mills, use of weed killers in cane fields of the superhumid region, will adversely affect the level of employment in the industry but secure gains to the economy. These policies, however, must be implemented carefully concurrently with the creation of job opportunities in other sectors of agriculture and in other sectors.

The technical and managerial ability of the estates is high, and their expertise should be made available to the whole sugar industry irrespective of ownership of the cane lands. This would benefit the economy as a whole, liberating the Department of Agriculture from its obligations in this field, and benefit the millers whose profits from milling of increased tonnages from cane lands of other farmers would compensate for the extra costs.

The cultivation of cane fallows and interlines on the millers' and large planters' cane lands should be mandatory. They would have to produce the food crops themselves, or preferably rent the land to small farmers and landless laborers. This will not be difficult or resented, given the attitudes of millers and large planters, as expressed in the "Programme for the Development of Foodcrop Production on Sugar Estates in Mauritius" prepared for the Mauritius Chamber of Agriculture in 1967. They have already shown their interest in production of potatoes which benefits from a minimum price guarantee of the Agricultural Marketing Board. They have started also the production of peanuts for the edible oil processing plant recently established. The creation of a land tax and guaranteed minimum prices would easily ensure the intensive cultivation of food crops on cane lands.

Most estates presently rent some of the cane fallow and interlines to their employees and small planters. Besides the additional revenue, they benefit from the structural improvements of the soil and its enrichment by the left-over organic and inorganic manure supplied to the food crops. They avoid also a large part of the expenses for weeding which they have to carry out. They normally expect the farmers to share some of the expenses for irrigation as the young sugar cane and food crops are irrigated simultaneously.

There is a great demand for these lands in certain areas resulting in rents which are relatively high especially when irrigation water is available. Policies should be formulated concerning the rents of these cane lands. Priority should be given to landless laborers and there should be ceiling prices on the rent based on the same criteria as for the land tax meant to encourage the estates and large planters to rent or cultivate those cane lands. The production of food crops by the estates and large planters would emphasize further the disparities in income and decrease the number of self-employed. Providing minimum price guarantees only to small planters would help improve income distribution.

Whereas large producers will be encouraged to continue with production of sugar cane, the small farmers should be encouraged to shift to year-round cultivation of food crops. The sugar cane farmers owning less than 2 acres of land are underemployed. They generally hire their services to the estates or find employment, when available, in other sectors. Only a small percentage of the self-employed small farmers cultivating sugar cane or both sugar cane and food crops depend on farming only. This compounds the unemployment problem.

This increase in the number of self-employed persons would have a tremendous impact on the unemployment problem. It is difficult to quantify the exact number of employment opportunities which would thus be created because of the present confused labor situation. The results of the model have however shown that this full utilization of land would absorb practically all the man-days available to the agricultural sector.

The small farmers besides producing about one-third of the sugar production and of the tea production are already the major producers of food crops and milk. Financial appeal would probably be sufficient to get the small sugar cane farmers to shift to full time food crop production, since most of them already produce food crops besides sugar cane either on their own land or on land rented from the sugar estates.

The small farmers will be responsible to a large extent for the production for import substitution. The elasticity of demand for imported foods is high, especially for commodities such as imported fruits, meats and processed vegetables. Import substitution will be relatively easy for those crops like potatoes and onions where the producers have already much experience and in which there have been marked improvements in production techniques. For other crops like peanuts, maize, rice, dry pulses (beans and peas) improvement in yields are a prerequisite. In the case of edible oil which may be produced from peanuts, the processing factory has already been established and incentives are needed to stimulate production.

Livestock

Livestock rearing is a part-time occupation in Mauritius, with very low returns to labor and no demand on scarce resources of land and capital. To improve production and save on imports, the structure of the industry would have to be changed, as very little progress can be made with the present situation. Besides the commercial broiler industry and herds of cattle already in existence, full time farmers should be encouraged to start livestock farms combining dairy, poultry and rabbits. Some 2,000 such farms a year would enable the industry to be self-sufficient over the next decade. Measures to ensure the creation of these farm units would be the provision of loans, subsidized stock, and feed in the initial stages. This would require tremendous organization, necessitate the training of the farmers, and close supervision by the extension service.

Food Crops

The returns per man-day equivalent on small sugar cane farms are lower than the minimum wage. The cultivation of food crops is more profitable. The small farmers of the Northern Plain obtain much higher returns to labor and management per arpent-

month from food crop than from cane cultivation. These are about 4 times higher for food crop purestand and 7 times higher in the case of food crops grown in interlines (18).

The major factor that has held up the production of food crops has been price uncertainty. Among other factors are: the competition from food commodities imported duty free or with low duty; the risk of the products being stolen before harvest; the unwillingness of banks to accept food crops as collateral because of uncertainty of price and yield as compared with sugar cane; and the lack of funds and attention given to research in food crop production.

The success of the shift of small farmers to full-time food crop production depends on policies being designed to overcome uncertainty and remove adverse factors. To this effect the Agricultural Marketing Board should establish guaranteed forward prices for crops like peanuts, maize, rice and garlic, the production of which need to be stimulated. These proved helpful as catalyst for improved production of potatoes and onions. The Cyclone and Drought Insurance Board should extend its protection, besides sugar cane, to other crops such as fruits which are affected by cyclones. More applied research should be done in the field of food crop production to bring about improvement in yields. The marketing system for food crops will have to be improved and a system of regular report on crops and prices established, for vegetables and other products not supported by guaranteed prices and insurance.

The absence of market information in the past has resulted in the alternate shortages and glut which encouraged imports. Heavy tariffs should be established to discourage imports. The import substitution of food crops will not subject Mauritius to retaliation from the supplying countries. Those countries have been shown to import practically nothing from Mauritius (Figure 12). Apart from controlling the import the government will also have to ensure the creation of facilities for processing, drying and storage of the crops. This has already been started successfully; examples are the oil processing factory and the ginger dehydrating plant.

Price Policy

If prices are to be used as a policy instrument to influence allocation of resources between crops, they will have to be planned in the light of the full range of government policies. They will have to be based on a consideration of the effects on the variability of agricultural prices, the relative prices of the various crops, and the ratio of output to input price. Price policy needed to stimulate production will have to be consumer oriented in the case of products for import substitution and producer oriented in the case of export diversification.

These measures would encourage the small farmers to concentrate on full-time crop production, and thus obtain higher income. They would thus become full-time farmers and would not hire their services to sugar estates or other sectors. This would leave employment opportunities for those presently unemployed. The same policy measures would stimulate landless laborers to lease cane fallows and interlines from estates for production of peanuts, maize, potatoes and beans. These activities would be more interesting financially than the minimum wages obtainable. The number of self-employed persons with earnings above minimum wages would increase and there would be smaller numbers seeking unproductive employment in the service sector.

The production for export diversification will also be largely the responsibility of small planters. Vegetables, garlic, ginger and other crops suitable for export diversification are already produced traditionally by them. The model has shown that export diversification is more important both from the foreign exchange earnings and employment angles than import substitution. It is particularly important to note the constraints placed on the level of exports other than sugar. Valuable crops like vegetables and fruits, potatoes, garlic and tea among others, would be at a much higher level and would displace sugar if there were not the constraints imposed due to the uncertainty of the market.

This indicates the need for serious attention to be given to the opening up of export markets for these products, and providing also necessary incentives to ensure the supply and quality of the products. The export markets can be secured by some political pressure on those countries presently exporting to Mauritius but importing hardly anything from Mauritius.

Any upward shift in the level of the constraints imposed on the export of other crops will affect favorably the employment level and the foreign exchange earnings. Land being a limiting resource, there will be a decrease in the acreage under sugar cane as land is shifted to other crops. The maintenance of earnings from sugar exports will depend on increases in yield or in price of sugar.

Wages Policy

The competitiveness of the exports on world markets, the prices to the consumer on the local market, and the level of employment on lands belonging to estates and large planters, are all linked to the level of wages. A wages policy is therefore warranted. The minimum wages regulation presently in operation should be broadened to ensure wage restraints to enable a larger number to benefit from employment earnings. Employers will have to be provided with incentives to adopt labor intensive instead of capital intensive methods of production. This can be achieved by the judicious manipulation of customs duties and import controls of labor saving machinery and by other tax incentives linked with the level of employment.

Higher consumption levels of locally produced food crops are however dependent on the purchasing power of the wages. The real wages can be improved without any wage increases by implementation of policies concerning welfare and fringe benefits.

The land use pattern and balance of payments obtained are dependent on the assumptions about the export and import prices, on the level of the land and export constraints, as well as on the yields for the different crops. These assumptions have important policy implications. Changes in any of these parameters will affect the results. Another important assumption is that all products are consumed locally or exported. This has implications concerning storage and marketing. It is also assumed that there will be enough incentives for farmers to produce the crops and adopt the crop rotations indicated by the results.

Export prices depend on the demand and supply situation on the overseas markets. To improve the competitiveness of local products, policies to ensure severe grading control of products, and regularity of supplies will be needed. The cost of transport

of perishable goods by air freight when the volume of the product is not large and regular may affect prices received by producers. The government may help to secure favorable tariffs from the international airlines serving the island.

The application of high tariffs on imported food crops that can be produced locally would stimulate local production. However, this must be done with caution and in conjunction with production policies so that the cost of living is not raised unduly. It would be necessary to phase out imports in a planned fashion. Some legislation already exists for certain crops which have been considered by the government as deserving support to replace imports. Rice, meat, edible oil, potatoes, onions and garlic are some of these.

The land constraints for 1980 assume that the proposed irrigation projects for the Northern Plain and the Western Coastal Region will be in operation, and that the government will continue to implement the policies about the Tea Development Scheme which is already in operation in the superhumid uplands. The land constraints also imply policies about improvement of land already under cultivation, such as derocking of the lands of the small farmers. This would increase the effective area that may be obtained from cane fallows and cane interlines for food crop production.

The results of the model assume production coefficients which are relatively conservative. Yields much higher than those stipulated in the model have already been obtained by the "best" small farmers. In the case of rice and maize and peanuts, the assumed increases in yields are within easy reach and would raise the profitability of the crops and make their production much more attractive. The increased profitability would raise the earnings of small farmers above the average wage rates and encourage the unemployed looking for work in other sectors to join the ranks of self-employed farmers. Policies to stimulate farmers to improve yields are needed, and applied research in varieties and cultivation techniques of food crops have to be intensified. The Mauritius Sugar Industry Research Institute should be provided with the necessary funds to expand its sector dealing with food crops. The Department of Agriculture would be able then to direct its efforts to the improvement of its extension service to bring to the farmers advice about technological improvements.

Public Programs

The improvement of the agricultural extension services is an aspect of agricultural policy which is most important in Mauritius. In an island with more than 30,000 small farmers there are less than a dozen extension officers, with the result that most of the small farmers do not benefit from the services of the Department. Experience of the Young Farmers Movement has shown that when the Government Extension Service Officer is efficient and in close contact with the farmer remarkable progress is achieved. Improved and enlarged extension service is essential if the small farmers are to play their part in import substitution and export diversification.

Public programs will have to be initiated to provide irrigation water, help with land improvements, help the farmers to increase the level of agricultural inputs such as fertilizers and chemicals for pest and disease control, to provide market information and marketing infrastructure and provide the financial support that may be needed for the price policies.

Special efforts will have to be made to group the small farmers into producer associations before the implementation of the Northern Plain and Western Coastal Irrigation Schemes. These producer associations, essential for both economic and technical reasons, will facilitate the supply control and marketing of products, reduce the cost of production and help in the promotion of export diversification.

One must recognize the multiplicity of and conflicts between the objectives aimed at, and to realize that each specific agricultural policy aims at a sub-optimization, with many other facets of the overall economic problem temporarily fixed. The criteria adopted at that level have therefore to be related to and harmonized with higher level criteria of the economic plan to achieve what is socially and economically desirable for the island.

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