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CONTENTS

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CONTENTS

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FUTURE DEMAND FOR FOOD IN CEYLON.*

T. JOGARATNAM

RELIABLE estimates of the future demand for food are of considerable importance in formulating plans of economic development. Economic development is accompanied by an increased demand for food and attempts must be made to avoid inflationary pressures when demand outruns supply, and surpluses when supply exceeds demand. Estimates of demand are also necessary to determine adequate levels of investment in agriculture.

The major factors determining long term movements in the aggregate demand for food are population and the pattern and level of per capita consumption. In general, an increase in the size of the population will raise demand at about the same rate. Changes in the age and sex structure of the population also influence food requirements. But, except in the case of commodities like milk foods where demand is strongly correlated with age, their effect is negligible over a period of ten to fifteen years and can be ignored. Increases in per capita consumption will be determined primarily by increases in income. The major feature of the income — consumption relationship is the tendency for food consumption to increase at a smaller proportionate rate than income. This relationship, if quantitatively measured for individual foods, is a valuable tool in estimating future growth in demand. Other factors such as variations in prices of food commodities, changes in consumer preferences, introduction of new technology, government policy etc. should also be taken into account in estimating demand. It is however difficult to measure the effect of these factors and demand studies in general pay more attention to the population and income effects.

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* Based on a Bulletin to be published in the Cornell University International Agricultural Development Series.

POPULATION AND FOOD REQUIREMENTS

The population effect on the demand for food is substantially higher than the income effect for a country like Ceylon which is characterized by a high rate of population increase. Given a rate of population increase of 2.8 per cent a year and an increase in real per caput income of 1 per cent a year and a rather high income elasticity for food of about 0.75, income would account for only 0.75 per cent of the increase in demand for food as against the 2.8 per cent by population. But as economic development proceeds apace, the income effect will assume greater importance. Thus for a country like Japan where population growth is low and income growth high, the income effect is estimated to be twice as high as the population effect. In the immediate years ahead however, population will be the more important factor influencing the demand for food in Ceylon and the need for accurate population projections is therefore great.

The rate of growth of population is determined by mortality, fertility and net migration rates. Population projections are based on assumptions regarding the future behaviour of these rates. The post — war period in Ceylon has been marked by drastic reductions in the death rate and it stands at about 8 per 1000 today. Conflicting opinions have however been expressed on the course that death rates will take in the future. N. K. Sarkar in his study "The Demography of Ceylon" expresses the view that any marked decline in the death rate is unlikely unless accompanied by a fundamental social transformation (12). Kingsley Davis in his study of the population of India argues that a continued low death rate without a modern economy and a low fertility rate is inconceivable (4). The relatively slow rate of economic development associated with rapid increases in population is likely to lead to a breakdown in health services and consequently to an upsurge in death rates. A recent study on Ceylon, on the other hand, projects population on the assumption of a further decline in mortality rates because of favourable prospects for economic development (13).

Comparable mortality rates from the more developed countries may suggest that death rates in Ceylon have about

reached the lowest levels possible. Crude death rates for some countries including Ceylon are shown below (14).

	1945-49	1950-54	1955-59	1960	1961	1962
United States	10.0	9.5	9.4	9.5	9.3	9.4
United Kingdom	11.6	11.7	11.6	11.5	11.0	11.9
Japan	11.8	9.4	7.6	7.6	7.4	7.5
Taiwan	15.1	10.0	8.0	6.9	6.7	6.4
Singapore	12.5	10.4	7.3	6.3	6.0	5.9
Ceylon	16.4	11.7	10.0	8.6	8.0	8.5

This does not however take into account the relatively youthful nature of Ceylon's population. The crude death rate is an inadequate measure for comparing mortality rates because it does not take into account differences in age composition (16). The infant mortality rate, which has been described as the "most sensitive index of social welfare and of sanitary improvements which we possess" is, as shown below, rather high for Ceylon (14).

	1945-49	1950-54	1955-59	1960	1961	1962
United States	33.3	28.1	26.4	26.0	25.3	25.3
United Kingdom	41.0	29.0	24.1	22.5	22.2	22.4
Sweden	25.7	20.0	17.0	16.6	15.8	15.3
Ceylon	112.0	77.0	66.0	56.8	52.7	52.8

This would suggest that extension of medical facilities would lead to further declines in death rates. If one also takes into account the progress in the field of medicine and the rapidity with which such advances are carried to the less developed countries, the possibilities of further decreases in the mortality rate in Ceylon cannot be ruled out.

Declining mortality rates have been accompanied by consistently high birth rates in Ceylon. The birth rate for Ceylon has averaged around 35 per 1000 during the last few years as against an average of around 17 per 1000 for countries such as the United Kingdom and Japan.

Birth rates in Ceylon have, if anything, shown a tendency to increase with improvements in medical and sanitary facilities (11). Fertility is influenced by many factors, primarily socio — economic. In the western countries,

development has been associated with declines in birth rates. It seems too early to say whether the less advanced countries will follow the same pattern. In general, the spread of education amongst the female population as well as their increasing participation in work outside the home leads not only to a rise in the age of marriage but also to fewer marriages. Studies in fertility trends in Ceylon indicate that an early marriage leads to a larger family than a late marriage (8). Urbanization accompanied by improved economic conditions may also lead to a decline in birth rates. More strenuous efforts on the part of the government to spread family planning techniques may also become an important factor influencing birth rates. It is however impossible to say what the net effect will be. The projection of birth rates always poses a problem and demographers get over this by making several assumptions regarding fertility. On the whole, it seems safe to conclude, barring any major breakthrough in carrying birth control techniques to the bulk of the population, that while birth rates may decline, they will do so only gradually.

The other factor influencing population trends is the net migration rate. In the past, especially in the late nineteenth and early twentieth century, immigration of South Indian labour has been an important factor determining population growth in Ceylon. But now it is a matter of government policy to restrict immigration and changes in migration rates have had little influence on population growth.

On the basis of the discussion presented above, one may arrive at certain conclusions regarding the future rate of the growth of population. Assuming constant fertility and declining mortality it is quite conceivable that rates of growth may approach 3 per cent per annum, if not exceed it. On the other hand, assuming a gradual decline in fertility rates and a more or less constant mortality rate, a rate of growth of around 2.5 per cent may be achieved. It is unlikely that in the immediate years ahead one could anticipate any lower rate of growth. The present annual rate of growth of population for Ceylon averages around 2.8 per cent and this rate will be used for projecting food requirements.

INCOME AND FOOD CONSUMPTION

Income has long been regarded as one of the major factors influencing the pattern and level of per capita consumption. Engel summarized this relationship in the well known law which states that the proportion of income spent on food declines with increases in income. This may however not hold good at very low levels of income, below the so called "poverty line." Since the primary consideration in the consumption of food is the satisfaction of hunger, low levels of income are characterized by proportionately higher levels of expenditure on food. It also follows that at low levels of income, the diet is likely to consist of a high proportion of cereals and starchy staples because of their relative cheapness as suppliers of calories (1). Once hunger is appeased, increased incomes tend to result in the consumption of a more expensive and varied diet consisting principally of dairy foods, meats, fruits and vegetables.

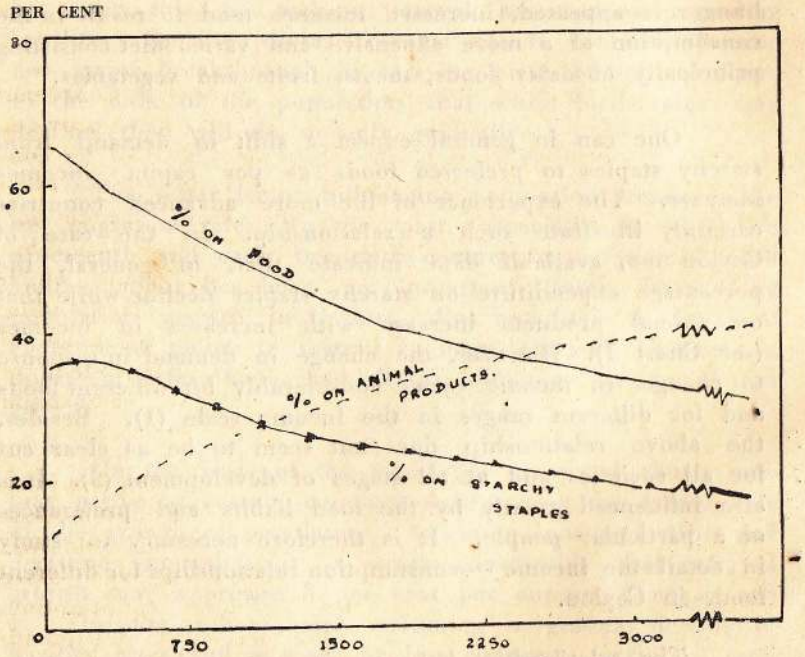
One can in general expect a shift in demand from starchy staples to preferred foods as per capita incomes increase. The experience of the more advanced countries certainly illustrate such a relationship. In the case of Ceylon too, available data indicate that, in general, the percentage expenditure on starchy staples decline while that on animal products increase with increases in incomes (see Chart 1). However, the change in demand in response to changes in income varies considerably for different foods and for different ranges in the income scale (1). Besides, the above relationship does not seem to be as clear cut for all societies and at all stages of development (9). It is also influenced greatly by the food habits and preferances of a particular people. It is therefore necessary to study in detail the income — consumption relationships for different foods in Ceylon.

The relationship between income and consumption may be estimated from cross sectional budgetary studies or time — series data. In a cross — section study, food consumption data from a representative sample of households over a given period of time are utilized for purposes of comparing consumption patterns over different income levels. It is essentially a static analysis based on the assumption

CHART 1.

CEYLON: PROPORTION OF TOTAL EXPENDITURE ON FOOD, AND PROPORTION OF TOTAL FOOD EXPENDITURE ON STARCHY STAPLES AND ANIMAL FOODS, CONSUMER SURVEY 1963*

PROPORTION OF TOTAL EXPENDITURE AND TOTAL FOOD EXPENDITURE



TWO MONTHLY INCOME OF SPENDING UNITS (Rupees)

* Based on data in Ceylon, Central Bank of Ceylon, **Survey of Consumer Finance, 1963.** (1965)

that income changes are the only variable affecting consumption. The usefulness of consumer surveys will depend on the extent of coverage, both geographical and over time. Most budget studies are limited to short periods of time and consequently one can only compare the behaviour of individuals at different income levels and assume that an individual will react in the same manner if his income increases.

A time — series analysis, on the other hand, attempts a study of the variations in consumption by the whole population over long periods of time. It is therefore more useful in studying the consumer behaviour of individuals as their incomes change. Unfortunately, reliable time — series data on production, prices, income and consumption are rarely available for the less developed countries. The income consumption relationship has therefore to be analysed on the basis of cross — sectional surveys.

In the case of Ceylon, the 1963 Survey of Consumer Finances carried out by the Central Bank of Ceylon provides suitable cross — sectional data and it may be used for constructing consumption functions. Consumption functions describe the relationship between per caput consumption and other variables, principally income. The relationship can be expressed in terms of elasticity coefficients which measure the percentage change in consumption corresponding to a 1 per cent increase in income. The advantage of using elasticity coefficients is that they are independent of units of measurement and therefore allow a comparison between different commodities and different countries.

The major problem in constructing consumption functions is to isolate the influence of income on consumption. Besides income other factors such as prices, household size, age and sex distribution, tastes and preferences and other such non — economic factors also influence consumption. The difficulty is that many of these factors are non-quantifyable. But it is possible to eliminate the influence of most of the other factors by stratification into homogeneous groups such that within each stratum all other factors except income are held equal. Thus each stratnm may contain only households with the same size, race or other variable. One may also explicitly allow for age — sex differences by considering

only per-caput consumption. While it is not possible to eliminate completely all other sources of variation, it is assumed that changes in per caput consumption are primarily due to changes in income (6).

The income — consumption relationship may be estimated on the basis of several different types of consumption functions (5). The major considerations in selecting the form of the function used are the statistical accuracy of the fit, the economic interpretation of the function and the simplicity of computation. In practice, the linear, logarithmic and semi — logarithmic forms have been widely used. The semi — logarithmic form would seem to be the most appropriate for food items because it allows for a decline in income elasticity as incomes increase. This is what one would normally expect in food consumption.

Analysis of Data.

Expenditure data from the 1963 Consumer Survey of Ceylon was used to calculate expenditure elasticities for various food items. The functions with the following forms were fitted to the data:

$$Y = a + bx$$
$$Y = a + b \log x$$
$$\text{Log } Y = a + b \log x.$$

Where y = per capita two monthly expenditure on food items, x = per capita two monthly total expenditure. The expenditure data was weighted by the number of individuals in each income group. Total expenditure rather than income was used as the explanatory variable. Income data was found unsatisfactory because of the tendency for reported expenditure to exceed reported incomes at lower income levels. Difficulties arising from under — reporting of incomes and valuing incomes in kind were thus avoided. No attempt was made to derive income elasticities from the expenditure elasticities. This is not a serious disadvantage as the elasticity of total expenditure with respect to income is, in general, close to unity for the less developed countries (10).

Of the three functions fitted, the semi — logarithmic form gave the best fit in terms of high correlation coefficients and low standard errors for the beta coefficients. Since theoretical considerations also suggest the semi-logarithmic form as being the most appropriate function for food products, this function was selected.

It should be mentioned here that the expenditure data used to compute the income — consumption relationships relate to expenditure at the retail level. Retail prices are higher than farm prices since they include distribution costs which remain relatively inelastic and, if anything, tend to rise at higher income levels due to greater processing and packaging. The effect of rising incomes is therefore greater at the retail level than at the farm level. Moreover, expenditure elasticities are also generally higher than quantity elasticities. This is because quantity elasticities leave out the effects of shifts to higher qualities or more highly processed foods. For planning agricultural production, the effect of income changes on quantities purchased is more relevant. But due to the absence of data on physical consumption, no estimates of quantity elasticities could be arrived at.

Consumption functions based on the expenditure data for some of the more important food commodities are shown in Table 1. Expenditure elasticities at the point of means are also shown in the table. It should be pointed out that the expenditure elasticity of demand for food items, using a semilog function, is not constant but declines with rising incomes. To be useful, the expenditure elasticities must be derived from the consumption functions for any given level of total expenditure.

The estimates of elasticities presented in the table can be compared with similar estimates for some other less developed countries (see Table 2). In general they seem to be of the same order of magnitude. The elasticity coefficient of .80 for total food seems rather high. It however bears comparison with elasticity coefficients for some urban African centres (9, 7). The high estimates for meat, milk products and eggs are also significant. Income increases are associated with a greatly increased demand for animal products. The negative elasticity coefficient for rationed rice should also be noted. It probably reflects a qualitative shift in demand for rice with increases in income.

TABLE 1. CEYLON: REGRESSION COEFFICIENTS (SEMILOG) BY MAJOR FOOD ITEMS.*

Food Items	Regression Equation	R^2	SE b	Elasticity 2/
Rationed Rice	y = 8.60 – 1.12x	.87	.003	– .29
Unrationed Rice	y = – 4.97 + 2.13x	.91	.004	.53
Rice	y = 3.62 + 1.00x	.64	.004	.13
Wheat Products	y = – 9.40 + 3.22x	.93	.005	.77
Meat	y = .18 + 4.75x	.97	.005	2.18
Fish	y = – 5.72 + 2.17x	.95	.003	.64
Eggs	y = – .11 + 2.86x	.87	.006	3.76
Pulse	y = 2.04 – .86x	.77	.003	.55
Vegetables	y = – 2.09 + 1.52x	.55	.008	.35
Fats and Oils	y = – 3.04 + 1.60x	.96	.002	.43
Milk & Milk Products	y = – .19 + 4.92x	.91	.009	2.47
Sugar	y = – 4.59 + 2.04x	.97	.002	.51
Total Food.	y = – .95 + .32x	.97	.032	.80

* See Text for Discussion

1/ Where y = per capita two monthly expenditure on food item, and x = per capita two monthly total expenditure.

2/ Expenditure elasticities of demand at point of means.

TABLE 2. SOUTHEAST ASIA: COEFFICIENTS OF INCOME ELASTICITY OF DEMAND, MAJOR FOOD GROUPS, IN TERMS OF QUANTITIES *

	S. E. Asia §	India	Indonesia	Philippines	Taiwan	Thailand
Cereals	0.5	0.5	0.5	0.2	0.1	0.2
Starchy roots	0.16	0.2	0.2	0.1	0.05	0.1
Pulses, nuts	0.3	0.3	0.3	0.3	0.3	0.25
Sugar	1.3	1.2	1.5	1.0	1.1	2.0
Vegetables and fruits	0.9	1.0	1.0	0.6	0.8	0.8
Fats and oils exl. butter	1.2	1.2	1.2	1.1	1.0	1.1
Milk and Milk products	1.8	1.7	3.0	2.0	3.0	3.0
Meat	1.5	1.4	1.6	1.5	1.0	1.4
Eggs	2.0	2.2	2.0	1.2	1.6	1.8
Fish	1.1	1.5	1.0	0.5	0.7	1.0

* Taken from FAO, **Agricultural Commodity Projections for 1970** (FAO, Commodity Review, Special Supplement, Rome, 1962), Table A–15.

§ Excluding Japan.

DEMAND PROJECTIONS.

The income — consumption relationships analysed above can be used to provide an estimate of the probable effect of an increase in income on per capita demand. This is however dependent on the assumptions made with regard to the growth of income. No attempt is made here to discuss in detail the basis for income projections. Rather, the estimates made in the various plans of economic development are taken into consideration. Thus the Ten Year Plan, 1957, estimated an annual rate of growth of 2.9 per cent in per capita incomes (2). However, according to the Short Term Implementation Plan, a rate of growth of 1 per cent was barely achieved during the first few years of the plan (3). With greater effort it is possible that a rate of growth of 2 per cent may be achieved. Since a good part of the increase in average incomes per head will be required for capital formation, the increase in per capita personal consumption is likely to be much less. Nevertheless, a rate of increase of 2 per cent per annum is used for projecting demand and it is well to bear in mind that this probably overestimates the rate of growth of demand.

It should also be emphasized that demand projections should preferably cover a period of five to ten years and avoid any short term estimates. This is because the influence of other factors such as prices are probably greater than that of income over a short period.

It is usual to estimate the rate of increase in food consumption as being equal to the rate of growth of population plus the product of the rate of growth in per capita income and the income elasticity (15). This may be expressed by the equation $d = p + gn$ where p and g are the rate of growth of population and per capita income and n the income elasticity of demand. While this provides a simple and ready method of ascertaining rates of increase of demand, it is not entirely satisfactory. This is because the above formula assumes a constant elasticity of demand over the entire income range whereas, as already mentioned, expenditure elasticities decrease with increasing incomes for a semi—logarithmic function. Nevertheless, because of the simplicity of computation, anticipated rates of growth of demand for certain categories of food items based on the above equation are given in Table 3. A rate of growth of population of 2.8 per cent and of per capita income of 2 per cent and the "income" elasticities presented in Table 1 are used for projection purposes.

One cannot claim any great accuracy for the above results. They are conditioned to a large extent by subjective choices relating especially to population and income. Moreover, the effect of prices as well as the various other factors that affect demand have been ignored. It may however be assumed that in the long run these forces will cancel themselves out. It is therefore felt that these estimates provide at least a rough estimate of the magnitude of the growth in demand and as such could prove valuable in formulating plans of economic development.

TABLE 3.

CEYLON: PROJECTED RATE OF GROWTH OF DEMAND FOR MAJOR FOOD ITEMS*

Food Items	Projected Rate of Growth of Demand
Rationed Rice	2.12
Unrationed Rice	3.76
Rice	2.96
Wheat Products	4.24
Meat	7.96
Fish	3.98
Pulses	3.80
Vegetables	3.40
Fats and Oils	3.56
Milk Products	7.64
Sugar	3.70
Total Food	4.30

* See text for discussion.

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THE ROLE AND PERFORMANCE OF CEYLONESE AGRICULTURE

A. B. ANDARAWEWA

THE role of agriculture in economic development has been the subject of intensive study in recent times. In Ceylon, the predominance of agriculture in the economy, from the point of view of aggregate output, employment and foreign exchange earnings has focussed attention on the need to develop this important sector. Since independence and specifically with the formulation of the Six Year Programme of Investment 1954/55 — 1959/60, a substantial proportion of public expenditures has been directed towards various programmes aimed at developing agriculture. A decade and half later Ceylon's agriculture is faced with the same problems but which have now reached alarming proportions. An increasing food import bill, mono-culture in both plantation and peasant agriculture with its attendent problems, increasing rural unemployment — all these factors have brought a greater awareness of the problems of economic development in general and particularly of agricultural development.

In this paper, an attempt is made to compare Ceylon with other developing nations using selected variables. This task was made easier as the data on these variables have already been estimated for 26 developing nations. The only estimation required was the data for Ceylon. The Economic Research Service, of the United States Department of Agriculture had compiled information for 26 countries selected to represent the major low-income areas of the world. On the basis of this information a report, "Changes in Agriculture in 26 Developing Nations 1948—1963" was prepared. The main objectives of that study "were (1) to measure levels and changes since 1948 in the agricultural output and productivity of less-developed countries and (2) to identify and to assess the roles of the major natural, technological,

economic, social and institutional factors associated with differences in these performance patterns".

The 26 countries compared in that study were Argentina, Brazil, Chile, Colombia, Costa Rica, Mexico, and Venezuela in Latin America; Nigeria and Tanganyika in Central Africa; UAR, Sudan and Tunisia in North Africa; Jordan, Israel, Greece, Turkey, Iran, Pakistan and India in the Near East and South Asia; Thailand, the Philippines, Taiwan and Japan in the Far East; and Yugoslavia, Poland and Spain in Central and Western Europe. These countries exhibit a diversity of natural resources, historical and cultural backgrounds, demographic features, political and other institutions and levels and patterns of agricultural and general economic development. They have one common characteristic in that they can be classed in what is known, in current literature, as developing countries.

These 26 countries were compared using selected variables pertaining to the whole economy, the importance and performance of agriculture and other characteristics. Data for the countries were available in the study referred to above, while the data for Ceylon were estimated. In the Appendix Ceylon is compared with the other countries. The units of measurement were changed into those used in Ceylon. Two of the variables relating to changes in price levels were dropped due to lack of data for Ceylon. In the case of a few variables, where data were lacking, estimates were made for comparable variables. Further where data were lacking for the exact periods used in the study, different periods were used.

In the Appendix the data for the selected variables comparing Ceylon with other developing countries are given, the data for the most favourable country are given separately. The data for countries excelling Ceylon are given under two heads those in the ECAFE region and the rest.

The variables selected relate first to the aggregate economy. They include (1) per capita income, (2) rates of increase in per capita incomes (3) population growth rates (4) rates of growth in Ceylon's domestic food demand and (5) the percentage of this growing demand accounted for by population growth rather than by rising per capita incomes.

Items 6 and 7 show the importance of agriculture and items 8 — 10 relate to the performance of the economy, indicated by rates of increases in agricultural production related to increases in demand for food. Items 11 — 12 indicate the role of agriculture as a source of foreign exchange earnings, items 13 — 18 relate to basis for gauging the levels and changes in the productivity of agriculture, while items 19 — 24 indicate factors which influence agricultural output and productivity. (6)

The per capita Gross Domestic Product of Ceylon in 1963 was about Rs. 600.00. Comparing it with the 1958 per capita incomes of 23 countries Ceylon ranked fifteenth. In the ECAFE region Japan was the only country which excelled Ceylon. However it ranked lower when the increases in per capita income during the last decade were compared. Five countries in the ECAFE region excelled Ceylon. Ceylon has an annual population growth of 2.5 percent and the increase in domestic demand for food is 2.9 percent a year. This increase in domestic food demand has occurred mainly due to the increase in population. This overall view does not indicate a dynamic and growing economy. On the other hand, among the countries compared, Ceylon ranks low in the various indices. The development of the economy during the last decade has not been spectacular and a accelerated rate of growth is required during the next decade.

Agriculture occupies a dominant position in the economy. Fifty two percent of the economically active population is in agriculture while 47 percent of the Gross Domestic Product originated in agriculture in 1960. In Ceylon agricultural development is a prerequisite to economic development as the foreign exchange for capital goods for industries, for imports of food, the substitution of imports by locally grown foodstuffs and absorption of unemployed at least in the short run have to be undertaken by the agricultural sector. Hence increased exports of the foreign exchange earning commodities and increased local production of imported food items are urgently required.

The performance of the agricultural sector has not been satisfactory. During 1952 — 63, the annual increase in crop output was 2.8 percent. Eighteen of the 27 countries compared excelled Ceylon's performance. Since 1955 however

the rate of increase has dropped to 2.1 percent, and is lower than the rate of growth of the population. Of the seven other countries studied in the ECAFE region, 6 surpassed Ceylon in the rate of increase of crop output during 1955—63. During this same period, the increase in per capita crop production and the difference between increase in crop output and increase in domestic food demand were negative.

During the period 1952 — 65, agricultural exports of Ceylon increased by 128 percent. This figure is low even among the countries in the ECAFE region. Further this increase reflects increased productivity of the plantation industries and not of the non-plantation or non-export sector of the agricultural sector. Vigorous replanting, increased fertilizer use, disease control, etc. have increased the productivity of the export plantation crops. However, although within Ceylon's agriculture the difference between the growth of the plantation and non-plantation sectors is sharp, it is not so marked when compared to the growth rates of other countries. Agricultural exports have increased but the rates of agricultural exports to agricultural output has declined; the ratio for 1962 was 94 percent of that for 1952. This could have partly been due to increased domestic consumption of coconut and tea and partly due to the slow increase in output during this period.

Several measures for gauging the productivity of agriculture are included. In 1962, the output per acre of arable land was around Rs. 725.00, and the output per agricultural worker in 1960 was Rs. 537.00. Again these figures have been weighted heavily by the plantation industries. Between 1946 and 1962 the area under crops increased by only 9.3 percent. Ceylon ranked lowest in this variable among the countries in the ECAFE region. Paddy yields are low — 37 bushels per acre compared with 123 bushels for Japan and increases in crop yields between 1952 and 1964 have been also low. The arable land available for future development is limited, though this limitation is common to most developing countries in Asia. The use of fertilizer in Ceylon is relatively high and the increase in amount of fertilizer used per acre between 1954 and 1964 was 63 pounds. Only Japan and Taiwan excelled Ceylon in current fertilizer

use and increases in fertilizer use among the ECAFE countries. However it must be noted that these figures have received weightage from the plantation sector (This is discussed in detail in later sections).

What is the potential for agricultural development in Ceylon? A few variables were studied to assess the prevalence of key factors required for development. The level of education in Ceylon is very high. The tenure system is favourable — 47 percent of holdings are owner-operated. However if the percent of holdings partly owned is added, 72 percent of the holdings in Ceylon are owner-operated or partly owner-operated. Only 3 of the 9 countries studied excel Ceylon in the provision of agricultural credit through institutional services. Thirtyfour percent of agricultural credit in 1962 was provided through institutional sources. However these figures related only to paddy cultivators. A study of Rural Indebtedness in 1957 showed that only 8 percent of the rural credit needs were met by institutional agencies. The quality of agricultural marketing facilities is also poor.

The above sections dealt with the data on the variables for Ceylon. The performance of Ceylon's economy and the agricultural sector were compared with those of other developing countries. No explanations for the lag in development etc. are offered. However, a few general comments could be be made. The data for the agricultural sector in Ceylon includes those for the plantation sector as well as the non-export sector. It is generally accepted that the plantation industries have maintained their levels of productivity and have responded to the various programmes for revitalising the sector. The plantation sector is efficient and the problems that it faces are not so much of production but those generated externally. The core of the agricultural problem in Ceylon is in the non-export sector. It is the performance of this sector that is important. No data were available except on a few of the variables in this sector. Hence it should be noted that the data for agriculture does not fully reflect the performance and the problems of Ceylonese domestic agriculture.

Secondly, during 1964 — 1962 the arable land area increased by only 9 percent and the area available for development is limited. Hence increased output has to be

achieved by increasing output per unit of land in use. This can be achieved through multiple cropping and by use of fertilizers and improved cultural methods. An analysis of the plantation sector indicates that the idea that the development of the sector has to be vertical rather than horizontal has been accepted. In fact the planting interests have repeatedly warned against increases in the area under export crops; though for reasons other than lack of suitable land. In the case of the non-export agricultural sector, too, efforts have been made to increase the productivity of the land in use. However the performance of this sector has been poor during the period studied.

The analysis suggests directions which are required to be taken to improve domestic agriculture. Specific policy prescriptions and changes required, however, need greater detailed discussion and is outside the scope of this paper, the purpose of which was to present a cross-sectional view of the performance of Ceylon's agriculture as compared to that of other developing countries. Another study pinpointing specific problems in the agricultural sector and policies for their solution need to be undertaken.

APPENDIX.

SOURCES:

The data for all the countries other than Ceylon have been estimated in "Changes in Agriculture in 26 Developing Nations, 1948 to 1963" Foreign Agricultural Economic Report No. 27. Economic Research Service, U. S. D. A. 1965. The data for Ceylon are from the following sources.

(a) Economic Survey of Asia and Far East, 1965.
(b) Consumer Finance Survey of Ceylon, Central Bank of Ceylon 1963.
(c) Annual Reports of the Central Bank of Ceylon.
(d) Census of Agriculture Vol. I and Vol. II 1962.
(e) Statistical Abstracts of Ceylon.
(f) Agricultural Development Proposals 1966–70, Ministry of Agriculture and Food.
(g) Census of Agriculture IV 1952.
(h) Administration Report of the Commissioner of Agrarian Services 1962–63.

COMPARISON BETWEEN CEYLON AND OTHER DEVELOPING COUNTRIES IN SELECTED VARIABLES.

Item	No. of Countries Reported.	Unit of Measure	Ceylon	Most favourable country	Least favourable country	26 Study Countries (1) Countries excelling Ceylon. ECAFE Countries	26 Study Countries (1) Countries excelling Ceylon. Other Countries
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1. Gross Domestic Product per Capita 1958 (1963)[2]	23	Rupees	612.75[a]	4308.75	270.75	Japan	Israel, Venezuela, Poland, Argentina, Chile, Spain, Mexico, Greece, Turkey, Costa Rica, Colombia Yugoslavia, UAR, Brazil.
2. Annual Income in real per Capita Income 1950/60. (1951–64)	27	percent	0.5[a]	8.9	–0.1	Japan, Taiwan Phillippines Thailand and India.	Yugoslavia, Poland, Greece, Spain, Costa Rica, Venzuela, Turkey, Brazil, UAR, Israel, Colombia, Mexico, Nigeria, Tunisia, Jordan, Tanganiyaka, Chile, Sudan.

Item	No. of Countries Reported	Unit of Measure	Ceylon	Most favourable country	Least favourable country	26 Study Countries (1) Countries excelling Ceylon. ECAFE Countries.	Other Countries.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
3. Population growth rate 1950/60 (1951–64)	27	percent	2.5 [a]	0.8	5.2	Japan, India, Iran, Pakistan.	Spain, Greece, Yugoslavia, Argentina, Tanganyika, Poland, Tunisia, UAR., Colombia, Chile.
4. Annual rate of Increase in domestic food demand 1950–60	27	percent	2.89	6.6	1.7	Taiwan, Japan, Thailand, Philippines, India.	Israel, Yogoslavia, Venezuela, Poland, Nigeria, Turkey, Brazil, Mexico, UAR, Sudan, Jordan, Colombia, Greece, Chile, Spain, Tunisia.
5. Part of Increase in domestic food demand accounted for by population growth.	27	percent	87	17	101	Japan, Taiwan, India, Thailand Philippines.	Yogoslavia, Spain, Greece, Poland, Costa Rica, UAR, Tunisia, Colombia, Venezuela Turkey, Brazil, Jordan, Tanganyika, Mexico, Nigeria, Israel, Chile, Sudan.
6. Population in Agriculture (1962)	21	percent	52 [b]	18	92	Japan, Thailand.	Isreal, Argentina, Venezuela, Poland, Chile, Colombia, Spain, Yugoslavia, Greece.
7. Gross Domestic product originating in Agriculture 1960....	22	percent	47 [c]	9	59	Japan, Taiwan, Philippines Thailand.	Venezuela, Israel, Chile, Argentina, Mexico, Yugoslavia, Poland, Spain, Brazil Greece, Costa, Rica, Colombia, Turkey.
8. Annual compound increases in crop output (a) 1948–63 (1952–63)	27	percent	2.8 [c]	9.7	–1.9	Philipines, Taiwan, Thailand, Iran, India.	Israel, India, Mexico, Costa Rica, Tanganyka, Yugoslavia, Turkey, Venezuela, Brazil, Greece, Poland, Argentina. Chile.
(b) 1955–63	27	percent	2.1	7.9	–1.9	Thailand, Taiwan, Iran, Philippines, India, Pakiftan.	Costa Rica, Sudan, Israel, Brazil, Venezuela, Yugoslavia, Colombia, Mexico, Poland, Turkey, Tanganyika, Argentina, Spain, U.A.R., Nigeria, Chile.

Item	No. of Countries Reported	Unit of Measure	Ceylon	Most favourable country	Least favourable country	26 Study Countries Countries excelling Ceylon. ECAFE Countries	Other Countries
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
9. Annual compound increases in crop output per capita of total population. (1955–63)	27	percent	–.6	3.8	–4.3	Thailand, Iran, Taiwan, India, Pakistan, Japan, Philippines.	Costa Rica, Yugoslavia, Sudan, Israel, Spain, Brazil, Poland Colombia, Tanganyika, Argentina, Mexico, Venezuela, Greece, Nigeria, U.A.R., Turkey, Chile.
10. Amount that annual compound growth in crop output exceeded that in domestic food demand 1955-63	27	percent	–.8	3.4	–5.6	Iran, Thailand Pakistan.	Costa Rica, Sudan, Argentina, Colombia, Brazil, Tanganyika, Spain, Mexico, Chile.
11. Increase in Agricultural Exports 1950–60 (1952–65)	26	percent	128[c]	2259	89	Iran, Japan, Thailand, India, Philippines.	Israel, Tanganyika, Yugoslavia, Mexico, Tunisia, Argentina, Greece, Jordon, Sudan. Spain, Nigeria.
12. Change in ratio of Agricultural experts to agricultural output 1960 as a percent of 1950, (1952 as a percent of 1962)	26	percent	94[c]	896	64	Iran, Japan, Thailand, India.	Israel, Tanganyika, Jordon, Yugoslavia, Tunisia, Argentina, Spain, Mexico, Greece, Nigeria, U.A.R.
13. Agricultural output per acre 1960 (1962)	23	Rupees	724[c].30[d]	4564.75	185.25	Japan, Taiwan.	U.A.R., Israel, Costa Rica, Colombia, Poland, Greece.
14. Agricultural output per Agricultural worker 1960.	20	Rupees	537[c].20[d]	8668.75	446.59	Japan, Taiwan, Pakistan, Philippines, India.	Israel, Argentine, Spain, Poland, Chile, Colombia, Venezuela Greece, Mexico, Yugoslavia, Brazil.
15. Increase in area of crops 1948–62 (1946–62)	23	percent	9.3[d]	68.5	–0.9	Philippines, Iran, Thailand, India, Pakistan Taiwan.	Israel, Turkey, Tanganyika, Brazil, Venezuela, Sudan, Mexico, Greece, Chile, Colombia.
16. Annual average yield of rice per acre 1961–63.	20	bushels	37.0[c]	123.7	24.14	Japan, Thailand, Iran.	Spain, UAR, Greece, Turkey, Yugoslavia, Argentina, Chile, Colombia, Brazil.

Item	No. of Countries Reported	Unit of Measure	Ceylon	Most favourable country	Least favourable country	26 Study Countries (1) Countries excelling Ceylon. ECAFE Countries.	Other Countries.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
17. Increases in crop yields 1948–62 (1952/54-1962/64 Maha only)[3]	23	percent	30.9	120.4	5.9	Japan, Thailand.	Israel, Sudan, Colombia, Greece, Yugoslavia, Spain, Poland.
18. Arable land expansion potential (rating)[4]	22	rating	111	1	IV	Iran, Thailand.	Brazil, Sudan, Tanganyika, Colombia, Greece, Yugoslavia, Spain, Poland.
19. Fertilizer nutrients used per acre of arable land 1962/63 (1964)	27	pounds	168.3[f]	594.2	1.1	Japan, Taiwan.	U.A.R., Costa Rica, Israel, Greece.
20. Increase in fertilizer nutrients per acre of arable land 1948–52–1952–53 and 1962-63 (1954-64)	24	pounds	62[f].7[g]	275.6	0	Japan Taiwan	Israel, Greece, Costa Rica, U.A.R, Yugoslavia, Poland.
21. Literacy level for population 15 yrs. and over	27	percent	68[a]	98	7	Japan, Philippines, Thailand	Israel, Poland, Spain Argentina, Chile, Greece, Costa Rica, Yugoslavia.
22. Percent of holdings owner operated (1962).	17	percent	47.3[g]	96	34	Thailand, Japan Taiwan, Philippines, Pakistan.	Greece, Jordon, Costa Rica, U.A.R., Mexico.
23. Agricultural credit from institutional sources (1962).	9	percent	34.2[h]	80	10	Japan.	Mexico, Venezuela.
24. Quality of Agricultural Marketing facilities[5]	27	rating	3	1	3	Japan, Taiwan Philippines, Iran.	Israel, Mexico, Costa Rica, Yugoslavia, Venezuela, Argentina, Chile, Spain, Jordon, Poland, Colombia, Brazil, Greece.

1. Listed in descending order.

2. The years in paranthesis indicate the period for which data for Ceylon is included.

3. Refers to paddy yields only.

4. The ratings I, II, III and IV indicate increases in arable land, of more than 150 percent, 75 – 149 percent, 25 – 74 percent, and under 25 percent, respectively.

5. The ratings 1, 2 and 3 indicate most favourable, moderately favourable and least favourable, respectively and are a function of the proportion of the population which is urban.

6. The objectives, methods, greater statistical detail of those variables, and more detailed explanations are found in the report.

N.B.—Conversion ratios:

US dollar	=	4.75 rupees;
Hectare	=	2.47 acs.
Kilogramme	=	2.2 lbs.
Bushels	=	45 lbs. of paddy.

ON THE BREEDING OF A DAIRY ANIMAL FOR THE LOW COUNTRY WET ZONE OF CEYLON

K. SANTHIRASEGARAM

INTRODUCTION

ACCORDING to the Development Plans of the Ministry of Agriculture (1966) it is proposed to utilize the coconut lands around Colombo to produce the milk required for the metropolis. There are according to present estimates (Pannabokke 1966) about 350,000 acres of coconut lands in the low country wet zone which girdle the city of Colombo. It must however, be pointed out that with the present impetus for replanting senile coconut holdings, and for the cultivation of other crops such as pineapple, banana, vegetables etc. together with the unsatisfactory physical feature of some land, the actual area available for animal production would be very much less than the total estimated area.

In addition to being close to the City, these lands are provided with excellent roads which make transport easy and cheap. These features further minimise the time lag between collection and disposal of this perishable commodity. A well organised dairy industry, in addition, could profitably produce meat and other commodities as by products, which could again find a ready market in the City.

The Coconut Research Institute has been aware of these possibilities for some time now, and has carried out considerable research into the problems of pasture cultivation under coconuts. It has been shown by Santhirasegaram (1964 a) that within the wet zone, pasture and fodder grasses will not compete with the coconuts for soil moisture; competition for nutrients could be completely eliminated by the application of fertilizers. Among the nutrients, competition is most severe for nitrogen followed by potassium (Santhirasegaram 1965), and it has been suggested that the incorporation of an effectively nodulating legume into the

pasture would at least reduce the amount of fertilizer nitrogen that has to be applied. Under the reduced light beneath coconuts Santhirasegaram and Ferdinandez (1965) found *Brachiaria miliiformis* to be a suitable grass and current work in progress at the Institute (Santhirasegaram 1966) suggests that legumes such as *Pureria phaseoloides*, *Centrosema pubecsens* and *Phaseolus atropurpurus* could be satisfactorily mixed with this grass, provided proper grazing practices are adopted.

Thus a high quality pasture can be grown in this area with no loss of coconut yields. The absence of a prolonged dry period would provide fresh feed the year round and eliminate the need to conserve. The economic success however, would depend on the efficiency of the grazing animal to convert this pasture into milk and meat. The area is hot and humid. This paper examines the available data on the breeding of an efficient dairy animal capable of withstanding the climatic conditions, and outlines a programme for future progress in the low country wet zone of Ceylon.

INDIGENOUS CATTLE

Nearly all coconut lands carry large numbers of indigenous cattle and buffaloe. The cattle are the descendents of a primitive type which have been indiscriminately crossed to various Indian breeds; and this population is called the "Sinhala Cattle". They are predominantly black in colour, but gradation from black to reddish brown is quite common; one would even encounter an occasional white animal. The "Dwarf Sinhala" *(Kuru harak)* found in the Natural Reserves and the remote areas of the south east sector of the island are believed to be the primitive forms. These animals are black in colour and are very much smaller than the estate cattle. The estate cattle have considerable amounts of Red Sindhi blood; the Red Sinhala in particular closely resembles the Red Sindhi. Other Indian breeds that have been crossed with the Sinhala are the Tharparkar and Sahiwal among milk breeds and Kangayam and Khillari among the draught breeds.

The average body weight of an adult Sinhala cow is 450 lbs. yielding 5 lbs./day over 250 days per lactation

(Santhirasegaram et al. 1966) under excellent management conditions. To produce this amount of milk the cows require good quality pasture plus concentrate feeding (Santhirasegaram and Goonesekera 1965), which make milk production with these animals rather uneconomical. Under normal estate conditions where the animals graze the natural weed growth, the milk yield is as low as 1.5 lb/day, and they are seldom milked.

EXOTIC BREEDS

Considering the possibilities of introducing temperate dairy breeds into the low country wet zone, Wright (1946) showed that the temperature and humidity of the area would be in excess of the tolerance limit of these breeds of cattle. Suggestions have been made at different times on the possibilities of introducing an established Indian breed such as the Red Sindhi. Large scale importation of this breed had not been possible for various reasons and as an alternative it had been suggested to gradually up grade the Sinhala to the Sindhi by back-crossing. As far as the performance of the Sindhi in Ceylon, a herd is being maintained at the Central Livestock Research Station, Polonnaruwa, in the Dry Zone. The herd average in 1961 was 2600 lb milk per lactation. (Dept. Agri. Ceylon, 1962) but it had dropped to 2200 lb in 1965 (Wijeratne personal communication) a similar observation has been made with the Red Sindhi in Malaya imported from Pakistan (Malaya Minist. Agric. 1962), and the decline in performance has been attributed to a more humid climate in Malaya compared to Pakistan. As far as efficiency of production, measured by yield/body weight ratio there would only be a slight improvement to be obtained from the Sindhi over the Sinhala.

CROSS BREEDING TO TEMPERATE CATTLE

A considerable number of attempts have been made in tropical countries to cross the Zebu to temperate breeds and in all instances considerable improvement in yield have been recorded in the F_1; some of these data where the yield of the Zebu are also known are presented in Table 1. The yield of the F_1 in every instance is higher than the mean of the two parents. This increase above the mean of the parents is due to heterosis or hybrid vigor and varies from 4 to 17 percent (Table 2). The number of records

TABLE 1.

MILK YIELD (lb / Lactation) OF CROSSBRED F_1 AND ZEBU PARENTS

Zebu	Crossbred (F_1)	% increase over Zebu	Source of data
4272	6977	63	Kartha (1941)
3000	6000	100	Matson (1929)
3798	6881	81	MacGuckin (1937)
3024	7651	53	Henderson (1927)
3000	4500	50	Matson (1929)
3084	4551	47	Indian Min. Agric. (1950)
3288	4294	30	Lecky (1949)
3000	5790	75	(Stonaker et al (1953)
2832	4764	68	Khishin (1949)
2290	4200	83	Mahadevan & Hutchison (1964)
1620	3850	137	Armour et al (1961)
1259	5489	336	De Pinho Morgado (1961)
1100	3305	300	Santhirasegaram (unpub)
800	4493	461	Wijeratne (1962)
800	2974	272	Wijeratne (1962)

TABLE 2.

MILK YIELD (lb / Lactation) OF ZEBU, EUROPEAN AND F_1 CROSSES

Zebu	European	Mean of parents	F_1	Diff. between mean of parents & F_1	% increase
4272	8023 (F)	6147	6968	830	13.5
3798	9406 (F)	6603	6881	278	4.2
800	7062 (F)	3931	4493	562	14.3
1259	8344 (F)	4801	5489	688	14.3
3288	4137 (J)	3712	4294	582	15.7
800	4294 (J)	2547	2974	427	16.8

(F) = Friesian ; (J) = Jersey.

where the yield of the two parents are also published is limited. For a given European breed the increase in the yield of the crossbred over the Zebu parent depends on the yield of the Zebu. In Table 3 are given the yield of three types of Zebu ranging from 1100 lb/lact. to 4270 lb/lact. and their ¼ and ½ breds with Friesian ; with increase in yield of the Zebu the percentage increase in the crossbred decreases.

TABLE 3.

MILK YIELD (lb/Lactation) OF ZEBU AND ¼ AND ½ CROSSES WITH FRIESIAN

Zebu	¼ bred	½ bred	Source of Information
1100	2219	3305	Santhirasegaram (unpublished)
2290	3710	4200	Mahadevan & Hutchison (1964)
4272	5982	9668	Kartha (1934)

There are three main lines available for further progress in this crossbreeding programme :—

(i) Back-cross to the European or upgrade.

(ii) Back-cross to the Zebu or downgrade.

(iii) Cross F_1 or maintain.

As far as upgrading or downgrading is concerned available literature suggests that the yield of the progeny would generally decrease. Maule (1953) reviewing the literature then available was inclined to favour upgrading to 5/8 European, but the increase to be obtained over the 4/8 or halfbred is wholly negligible and considered to be of no practical significance. In the few studies with downgrading the Zebu the results have been a progressive decline in yield. In Figure 1 the data of Kartha (1934) of downgrading F_1 to the Zebu and that of Lecky (1951) of upgrading F_1 to the European are plotted to give a complete spectrum from pure Zebu through varying proportions of the crossbreds to the pure European. Both data are for the Red Sindhi and

Friesian in India. Normally one would expect a progressive increase in yield as the percent of Friesian in the crossbred is increased. This is shown as expected and the area between the expected and observed curves is probably due to depression caused by the environment and is termed "environmental depression". The effect of the tropical environment increases with increase in the percent of Friesian blood and is greatest on the pure Friesian. It would then appear that the crossbred with 50% of each breed would be the most suitable animal from a practical point of view.

Diverse opinion has been expressed with respect to the milk yield of the F_2 and subsequent generations. The old view had been that F_2 would segregate widely resulting in mongrels. Opposed to this is the polygenic theory which suggests that there would be no such wide segregation. Mahadevan (1958) discussing this aspect of animal breeding demonstrated on theoretical grounds that if the standard deviation in the F_1 is 900 lb, then in the F_2 it would be 2300 lb. on the one gene hypothesis, but only 1120 lb. in the ten gene (polygenic) theory. There is no dispute as to the polygenic nature of milk yield inheritance, but, in the few instances where the F_2 has been studied the yield, without exception, has been disappointingly (Table 4) low compared to the F_1. It should also be noted that not only is there a reduction in the average yield but also a reduction in the maximum yields recorded. Unless the population tested were insufficient, even if there was wide segregation in the F_2, the spectrum of yield observed in the F_1 should at least be approached.

TABLE 4.

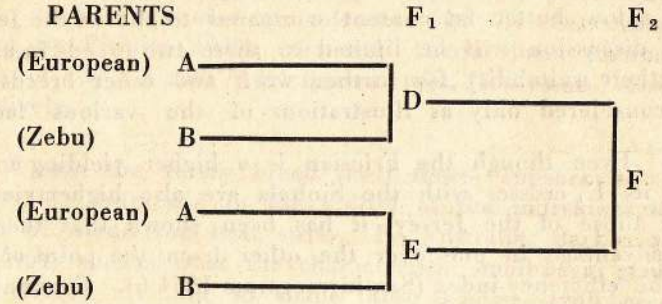
MILK YIELD (lb/Lactation) OF F_1 AND F_2 CROSSBREDS.

Generation	Ayr × Sindhi §		Fri × Sinhala*		Jer × Sinhala*	
	Av.	Max.	Av.	Max.	Av.	Max.
F_1	5122	9731	3513	5565	2508	3236
F_2	4068	8380	2187	3397	1907	2637

§ Littlewood (1933); * Wijeratne (personal comm.)

It has been suggested by various workers (Maule, 1953 and Mahadevan, 1958) that the reduction in yield of the F_2 and subsequent generations was due to an increase in the coefficient of inbreeding. According to some estimates reviewed by Rice et. al. (1957), the milk yield of cows could be depressed by as much as 80–210 lb. per 305 day lactation for every 1 percent increase in the coefficient of inbreeding.

Usually in a crossbreeding programme a small herd of fairly closely related animals are mated to one or at most-two imported bulls or artifically inseminated with semen from most probably a single bull. Under these circumstances it would not be uncommon to encounter F_2 generations which fit into the pedigree scheme shown below; which would have an inbreeding coefficient of 12.5% purely in relation to the exotic parent alone.



[Pedigree scheme of the F_2 crossbred with inbreeding coefficient of 12.5% due to the European parent alone].

A rather striking example of inbreeding was provided by Bonadonna et al. (1966) where the number of inbred animals increased from 16% in 1958 to 55 percent in 1964, — within a matter of 8 years — with the inbreeding coefficient ranging from 4 to 25 percent. They believed that this was due to indiscriminate application of artificial insemination. Thus it is highly probable that inbreeding could to a large extent bring about the observed depressions in the F_2 and subsequent generations.

SELECTION OF THE EXOTIC BREED

In all tropical countries, including Ceylon, that there had been a tendency to favour the Friesian, is shown by

the amount of published data available. There had been some attempt to use the Jersey and still fewer attempts with Ayrshire, Shorthorn and Brown Swiss. The main reason for the choice of Friesian appears to be the high yield of that breed compared to others.

In the choice of the exotic breed not only the total milk yield but such characters as efficiency, i.e. the yield/body weight ratio, ability to withstand the tropical environment including climate and disease, degeneration due to dwarfing, milk-ability, genetic combining ability etc. need to be considered.

In Ceylon considerable work has been carried out in crossbreeding the Friesian and Jersey with the Sinhala; these two breeds are contrasting to some extent in that the Friesian is a higher yielding and bigger animal but its milk has a low butter fat content compared to that of the Jersey. The discussion will be limited to these two breeds in assessing their suitability for further work and other breeds will be considered only as illustrations of the various factors.

Even though the Friesian is a higher yielding animal and its F_1 crosses with the Sinhala are also higher yielding than those of the Jersey, it has been shown that there is no advantage in one over the other from the point of view of the efficiency index (Santhirasegaram 1964 b). Examination of Table 5 will show that the indices of the common European breeds are practically the same and so are their crosses with the Sinhala. This would mean that a big animal yields more than a small animal. But from the point of

TABLE 5.

EFFICIENCY INDICES (gal./Lact./lb. body wt.) OF THREE EUROPEAN BREEDS AND THEIR CROSSES WITH THE SINHALA (Santhirasegaram 1964 b).

	European in England	European in Ceylon	European x Sinhala Crosses (F_1) in Ceylon
Friesian	0.72	0.58	0.66
Ayrshire	0.75	0.59	0.68
Jersey	0.74	0.58	0.70

view of percent butter fat content the Jersey is superior to the Friesian and in the F_1 crosses the total butter fat yield per lactation of the Jersey cross would be disproportionately higher than that of the others.

There is considerable evidence to show that the Jersey is better adapted to the tropical climate than the Friesian. Eckles (1939) considering the introduction and breeding of cattle in the United States of America suggested the success of the Jersey in the Southern States (and the Friesian in the Northern States) to be due to the better adaptability of the Jersey to the sub-tropical conditions there. The success in the evolution of the Jamaica Hope breed of cattle which comprise nearly 80 percent Jersey blood compared to the less successful progress in Trinidad with the Friesian is often quoted as another example of the superiority of the Jersey. In a study of heat tolerance in Greece, Allman (quoted by Philips 1949) obtained Iberia heat tolerance indices of 92, 84 and 76 for Brown Swiss, Jersey and Friesian respectively.

Within the Jersey breed itself there appears to be considerable difference in the ability of the individual animals to withstand the heat stress. In Australia, Barker and Nay (1964) showed that the characteristic small baggy glands of the Jersey resemble in shape those of Zebu – type breeds, and they suggested that "the small baggy gland of the Jersey may be the primitive type, from which the large baggy glands of the Zebu has developed". They further contend that "the higher heritabilities of gland diameter and volume further support the hypothesis that adaptive selection is favouring Jersey animals with large Zebu-type glands". This would then explain the observations of Allen (1962) that some of the Jersey crosses behaved similar to the pure Jersey while others behaved intermediate to the pure Zebu and Jersey, in his studies on sweating.

Ability to withstand disease is best measured by calf mortality. In the experiment in progress at Karagoda Uyangoda in Ceylon the percent mortality during the three year period ending September 1966, were 16.6 and 34.5 for the Jersey and Friesian crosses respectively. De Pinho Morgado (1961) recorded figures of 21.4 percent and 36.4 percent for

Jersey and Friesian crosses respectively in the low lands of Mozambique.

Dwarfing appears to be a character of animals in the hot and humid climate of the tropics (Epstein 1965). The cause has been attributed to a direct effect of the climate by Wright (1964), while Hammond (1947) was of the view that it was an indirect effect of the climate through the quality of the feed available. Whatever may be the cause, the bigger the animal at the initial stages the greater the degeneration in subsequent generations. This would again favour the Jersey over the Friesian. This might well be a possible explanation for the greater reduction in the average and maximum yield in the F_2 of the Friesian crosses compared to the Jersey crosses in Ceylon (see Table 4).

It will be noted that in all factors considered the Jersey is equal to if not superior to the Friesian in its suitability for crossbreeding with the local Sinhala cattle.

BUFFALOE

It wass earlier mentioned that in Ceylon there is a local breed of buffaloe. Just as the Sinhala cattle the Sinhala buffaloe is an inefficient and uneconomic animal. Attempts have been recently made to cross breed them to the Murrah breed imported from the Indian sub-continent. This animal under Ceylon conditions produces 3676 lb. milk/lact. and weighs 1128 lb.; its crosses with the local buffaloe produce 2389 lb. milk/lac. and weigh 888 lb. The efficiedcy indices are not far superior to the Sinhala cattle itself. It is suggested that while the Murrah and its crosses with the local buffaloe may be suitable for certain environmental conditions, they would not be sufficiently efficient for dairy production under coconuts tn the low country wet zone.

PROGRAMME OF BREEDING.

The foregoing discussion of available evidence has shown that the Jersay would be a suitable breed to cross the Sinhala, that the half-breed would perform satisfactorily and to maintain the level of production of the subsequent generations inbreeding should be kept at a minimum.

In the low country wet zone the majority of land holdings are relatively small and skill is limited as in the

rest of the island, and the venture would be only secondary, to provide some additional income. Thus the programme should be simple and easy to follow and the animal so evolved should be able to withstand considerable amount of mismanagement and poor feeding for at least some time to come.

The presence of considerable variation to heat tolerance within the Jersey has already been pointed out. Careful selection has to be made by trained personnel. Within a breed itself high heat tolerance and low production appears to be associated (Epstein 1965) and a satisfactory selection criterion has to be worked out. This alone may greatly reduce the variation in performance to be obtained in the crossbreds.

Inbreeding may be eliminated by employing large herds in the breeding programme. This however is not possible due to the size of land holdings. In the alternative then, a large number of smaller holdings should work as a unit. If necessary the holdings in a village may form an effective unit. Each unit must have a stud centre. Appropriate measures should be worked out such that at the F_1 generation, mating does not occur within a unit. Bull calves should be exchanged among the units for the production of F_2 and subsequent generations.

Artificial insemination may be adopted, but under present conditions the results have been very disappointing (Santhirasegaram 1966). If these difficulties could be overcome, then necessary precautions must be taken to keep inbreeding at the minimum level possible.

If a large number of units as envisaged could be put into operation it should be possible to select and further minimise variation. This will lend a much greater chance of obtaining high producing families and lines which may then be followed up to stabilise a suitable type as has been done in Jamaica in producing the Jamaica Hope and as in Texas in producing the Santa Gertrudis.

Such a programme of breeding and selection is possible with a central organization such as the Department of Agriculture and or the Animal Husbandry Corporation to be set up.

These organisations should test and select the studs at all stages and eliminate inbreeding particularly at the early stages.

Regarding breeding for meat production in Ceylon one can do no better than to heartily endorse the views and programme put forward by Mahadevan (1966).

In both programmes, the co-operation and enthusiastic participation of the producers have to be sought after. In this respect the facilities and concessions for animal producers in the coconut areas announced recently by the Minister of Agriculture are most welcome.

ACKNOWLEDGEMENT

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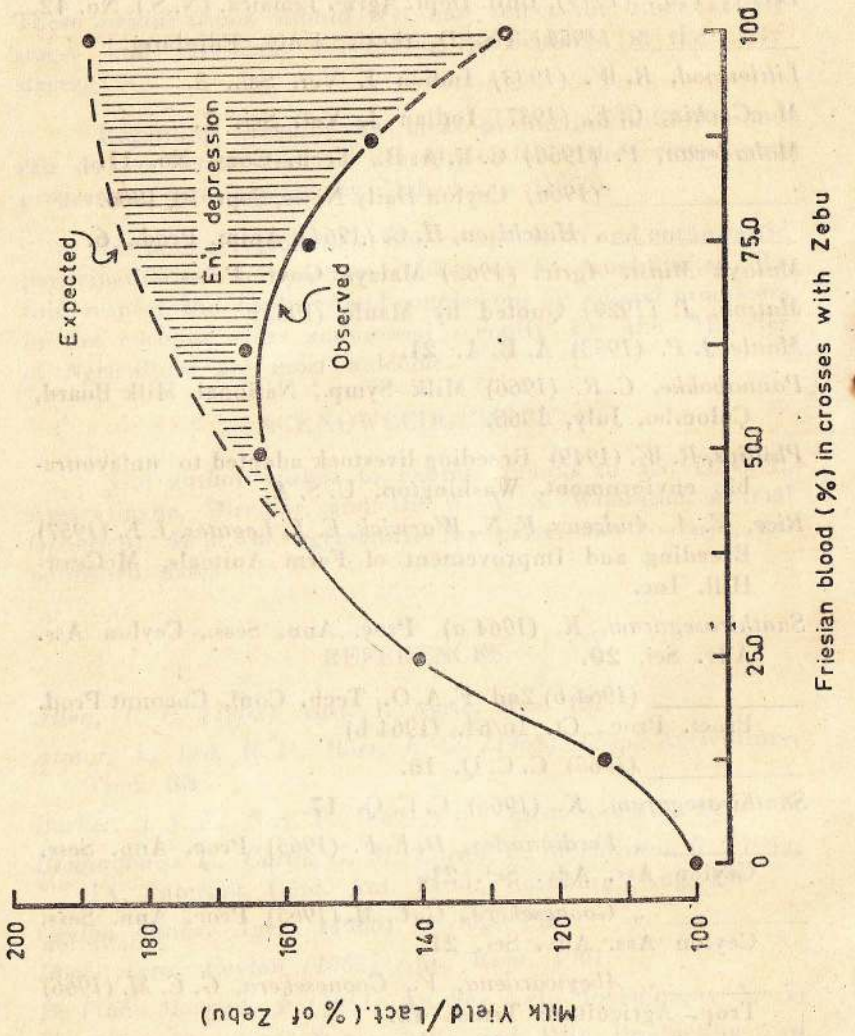


FIGURE 1.

THE SUPPLEMENTARY VALUE OF GINGELLY (Sesamum indicum D. C.) OIL MEAL AS A PROTEIN SOURCE IN THE DIET OF WHITE LEGHORN LAYERS.

H. KARUNAJEEWA

POULTRY production and other livestock enterprises in tropical countries often turn out to be unprofitable businesses, primarily due to the scarcity of feedstuffs containing proteins of high biological value. The use of fish meal which forms the principal protein source in tropical poultry diets has many disadvantages. It is quite expensive in comparison to other feedstuffs, and is also subject to rapid deterioration during storage. Consequently the quality of the fish meal available in the market is highly variable. Under these circumstances, the need for a vegetable protein source comparable in nutritive value to soybean oil meal is imperative. Gingelly (*Sesamum indicum*) oil meal, which has a relatively high crude protein content deserves consideration as a possible alternative to animal protein feedstuffs.

Almquist and Grau (1944) observed that gingelly oil meal (GOM) along with soybean oil meal (SOM) exerted a marked supplementary effect on the growth and utilization of feed by White Leghorn chicks. Gingelly protein by itself, however, was found to be unsatisfactory. Similar results were obtained by Hale and Bolton (1948) with respect to egg production and maintenance of body weights in laying birds. It was also pointed out by these workers that although the GOM gave production values slightly lower than fish meal or groundnut cake meal, the differences were not statistically significant.

The unfavourable qualities of GOM have been attributed to the deficiencies of lysine, vitamin B_{12} and an unidentified factor found in SOM, and in albumin (Patrick 1953). The nutritive value of GOM may also be related to the

method of processing. For instance Kienholz *et al.* (1960), Lease *et al.* (1960) and Lease (1966) have observed that autoclaving of GOM improved the availability of zinc in these meals. The nutritive value of GOM could also be improved by supplementing it with synthetic lysine, procaine penicillin, chlortetracycline and vitamin B_{12} (Patrick, 1953).

An experiment was conducted to determine whether GOM from the expeller process and containing 41% crude protein could be successfully supplemented with coconut oil meal, minimal amounts of fish meal, oxytetracycline and a fermentation product (Vigofac).

EXPERIMENTAL

Seventy two, nine-month old inbred White Leghorn pullets in laying cages were grouped into eight lots. The experimental diets A, B, C and D (Table 1) were fed to these birds for four 28 day periods. Each treatment was replicated twice. Daily egg production, body weights, egg weights, feed consumption and mortality records were maintained throughout the duration of the experiment.

This experiment was carried out at the Poultry Unit of the Department of Agriculture, University of Ceylon, Peradeniya. It commenced on 26th April, 1962 and was concluded on 16th August, 1962.

TABLE 1.

COMPOSITION OF EXPERIMENTAL DIETS.

Feed Ingredients	Diet A. %	Diet B. %	Diet C. %	Diet D. %
Coconut oil meal	30.0	30.0	30.0	30.0
Gingelly oil meal (41%)	10.0	15.0	5.0	0.0
Maize meal	40.0	40.0	40.0	40.0
Rice polish	10.0	10.0	10.0	10.0
Fish meal (55%)	5.0	0.0	10.0	15.0
Mineral mixture	2.0	2.0	2.0	2.0
Shell grit	3.0	3.0	3.0	3.0

To 100 pounds of each diet the following were added :—

73 grams Vigofac; 10 grams Rovimix and 113 grams of TM 3 + 3.

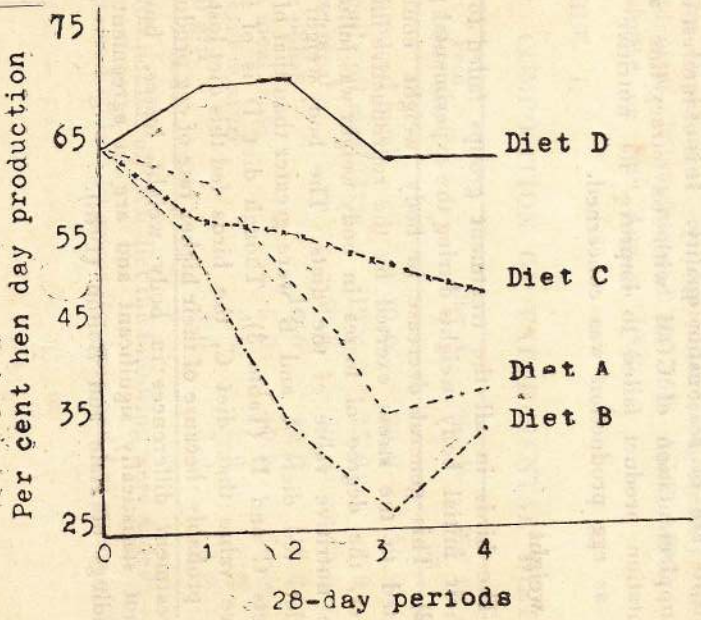
RESULTS AND DISCUSSION

Egg production

The level of egg production of pullets fed fish meal as the main source of protein (Diet D) was superior to that of those fed varying levels (Diets A, B and C) of both fish meal and GOM (Table 3 and Figure 1). However, the difference of 13 per cent in egg production between birds fed diet D and diet C was not statistically significant. The differences in egg production between the birds fed diet D and those fed diets A and B were statistically significant ($P < 0.05$) while there were no significant differences in egg production between the groups fed diets A and C. The higher rate of egg production in birds fed 15 per cent fish meal in the diet was undoubtedly due to the optimum quantity and assortment of amino acids, particularly methionine and lysine in this diet (Table 2). It is clearly evident from these results that GOM at levels of 10 percent or more in the diets tested is not satisfactory for maintenance of egg production. However, there appears to be a possibility of using about 5 percent GOM along with 10 percent fish meal in laying diets provided both these ingredients are of reasonable quality. It is of interest to note that supplementation of GOM with oxytetracycline and a fermentation product failed to improve its nutritive value as far as egg production was concerned.

Body weight

The birds in all the treatment groups failed to maintain their initial body weights during the experimental period (Fig. 2). This general decrease in body weight could be attributed to the stress exerted by the reproductive impulse. However, the degree of losses in body weight was influenced by the nutritive value of the diets. The body weight losses in pullets fed diets A and B were greater than that of those fed diets C and D (Table 3). Though diet D is of higher nutritive value than diet C, the birds fed this diet lost more weight probably because of their higher rate of egg production. The treatment differences in body weight losses, however, were not statistically significant and are in agreement with the findings of Hale and Bolton (1948).



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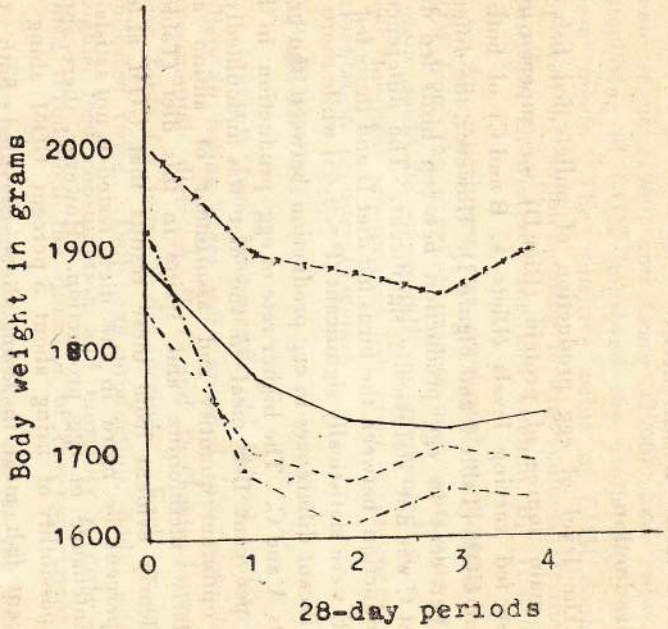

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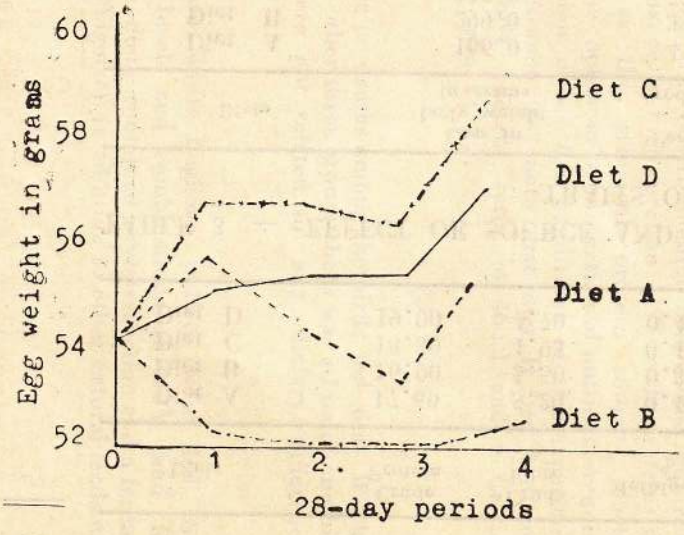

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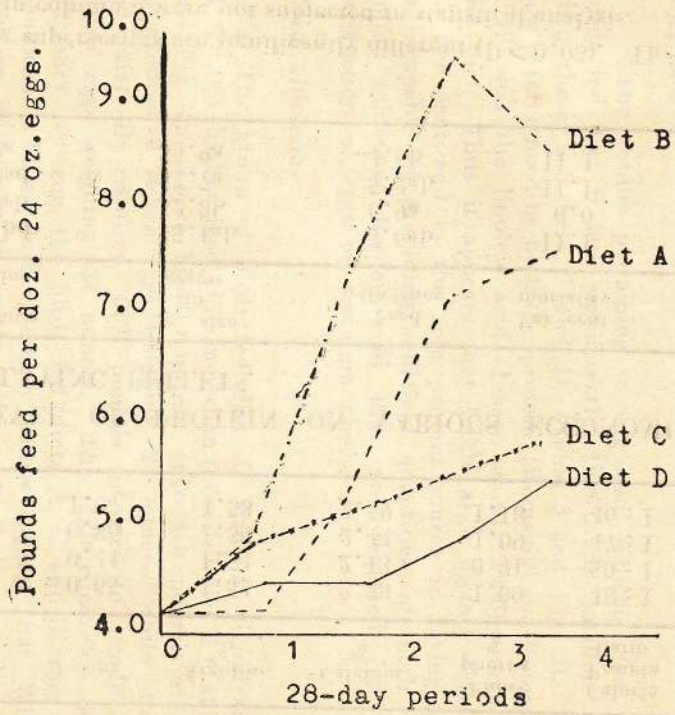

Figure 4.

TABLE 2 — THE CONTENT OF SOME NUTRIENTS IN THE EXPERIMENTAL DIETS

Diets	Crude Protein %	Crude Fibre %	Methionine %	Lysine %	Arginine %	Calcium %	Phos-phorus %	Calorie Protein Ratio
Diet A	17.60	5.20	0.40	0.65	1.54	2.28	1.00	48 : 1
Diet B	16.90	5.50	0.38	0.44	1.54	2.13	0.91	50 : 1
Diet C	18.30	4.93	0.42	0.86	1.54	2.44	1.09	47 : 1
Diet D	19.00	4.70	0.44	1.07	1.53	2.59	1.18	46 : 1

TABLE 3 — EFFECT OF SOURCE AND LEVEL OF PROTEIN ON VARIOUS ECCONOMIC TRAITS OF LAYING PULLETS.

Diets	Loss in body weight in grams	Per cent egg production	Egg size in grams	Feed efficiency	Per cent mortality
Diet A	166.0	47.5bd	55.4ab	5.6ab	11.1
Diet B	299.0	39.0cb	52.8b	6.9a	0.0
Diet C	115.0	53.9ad	57.7a	5.2ab	11.1
Diet D	157.0	66.9a	55.9a	4.6b	11.1

* Mean values.

Within columns, figures not having similar superscripts are significantly different ($P < 0.05$). There were no significant differences in column 1. Values in column 5 were not subjected to statistical analysis.

Egg size

The results pertaining to egg size indicate that the birds fed diet B laid significantly ($P < 0.05$) smaller eggs than those fed diets C and D (Table 3 and Fig. 3). Egg size is influenced by both the protein (Romanoff and Romanoff, 1949) and the linoleic acid (Jensen *et al.*, 1958) contents of the diet. Thus it appears that GOM at a dietary level of 15 per cent and as the sole protein source in laying diets is incapable of providing sufficient quantities of both the amino acids and linoleic acid that are required for the production of eggs of optimum size.

Feed efficiency

The group of birds fed diet D had a significantly ($P < 0.05$) higher feed efficiency than those fed diet B (Table 3 and Fig. 4). These birds required only 4.6 pounds of feed to produce a dozen eggs weighing 24 ounces while those fed diet B required 6.9 pounds of feed to produce a dozen eggs weighing 24 ounces. The differences in feed efficiency between the birds fed diets A, C and D were not significant. These feed efficiency values suggest that White Leghorn pullets in the early phase of their reproductive life and under tropical environmental conditions require for efficient performance a high protein (19% crude protein) diet with fish meal as the principal protein source. Such a diet provides the optimum combination of nutrients required for egg production under the conditions of this experiment. It is of significance to note that diet D had a Calorie (Productive energy) protein ratio of 46 : 1 and a Calcium to Phosphorous ratio of 2.6 : 1.1.

Mortality

There were no deaths among the birds fed diet B while in each of the other three groups there was a loss of one bird. These deaths were not related to any dietary differences.

Summary

Seventy two White Leghorn pullets were fed diets containing four levels and combinations of GOM and fish meal. All these diets contained oxytetracycline and a fermentation product (Vigofac) in addition to other natural feedstuffs.

The reproductive performance of the birds fed the diet with 15 percent fish meal (Diet D) was superior to that of those fed the other experimental diets. Diet D appeared to have the optimum combination of nutrients required by White Leghorn pullets for egg production under tropical environmental conditions. Supplementation of diets with oxytetracycline and the fermentation product (Vigofac) failed to improve the nutritive value of GOM.

It appears that a maximum of 5 percent GOM could be incorporated into a diet fed to White Leghorn pullets without causing a significant decrease in their reproductive performance.

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THE AGRICULTURAL GEOGRAPHY OF THE KARACHCHI — IRANAMADU COLONY

H. N. C. FONSEKA

THE Karachchi — Iranamadu colony is one of 57 peasant colonisation schemes in the Dry Zone in 1959.* It is situated in the Jaffna district and lies below the Iranamadu tank. The colony was established in 1936 and by successive stages, altogether 1630 allottees had been settled by 1959. In the older parts of the colony, the standard size of allotments is five acres of low-land (land provided with irrigation water) and three acres of high-land (land not provided with irrigation water), while in the tracts settled in 1955 and after, it is three acres low-land and two acres high-land.

THE PHYSICAL BACKGROUND

The area occupied by this colony forms a part of the North Central Lowlands and Uplands. Topographically the area is a level plain less than 100 feet in elevation. (Fig. 1) The Kanakarayan *aru* drains the excess water of the Iranamadu tank. Most of the other streams in this area maintain their flow only during the wet season. Some rivers disappear beneath the Miocene limestone belt which lies to the north of the area.

The meteorological stations in this area do not record temperature. The closest temperature recording station is Jaffna, at ten feet above mean sea level and about 40 miles away. The temperature statistics for this station are used to illustrate the temperature conditions of this area. The coastal situation of Jaffna which acts as a limiting factor in this respect should be noted. Inland, the daily range of temperature would be slightly greater.

* **Administration Report of the Land Commissioner for 1959** (1960) Government Press, Colombo.

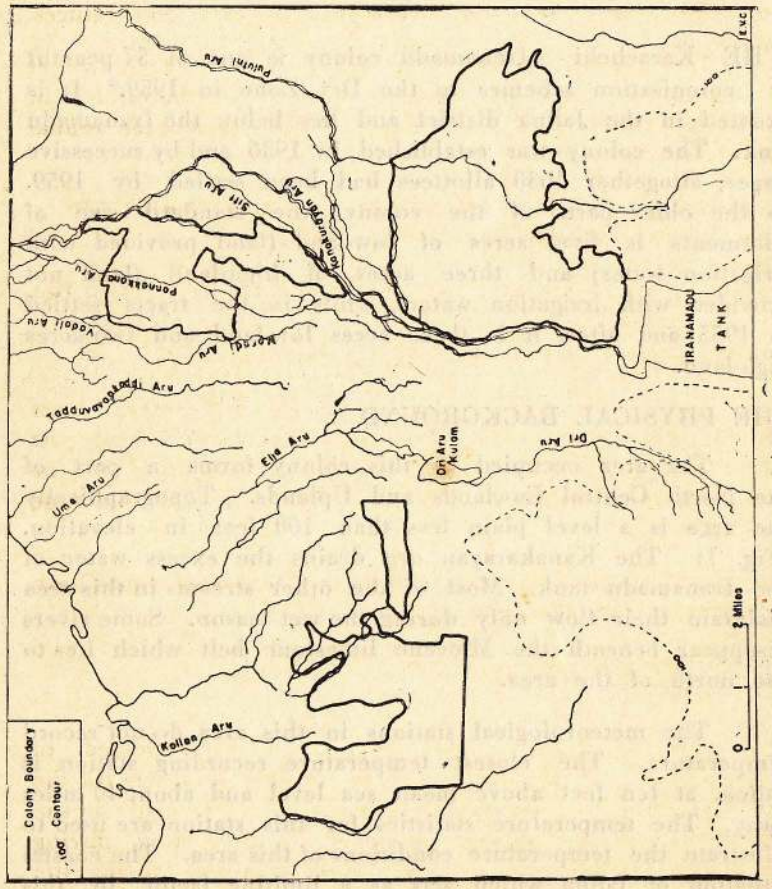

Fig. 1 Karachchi-Iranamadu Colony: relief and drainage

MEAN MONTHLY TEMPERATURES AT JAFFNA (°F)

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
77.6	78.9	82.2	84.9	84.9	83.8	83.0	82.6	82.8	81.6	79.4	77.8

Source: *Report on the Colombo Observatory, 1957.*

The mean annual temperature for Jaffna is 81.6°F. The mean monthly temperatures are high with little variation from month to month. The season of the north - east monsoon, November — January, records slightly lower temperatures.

The rainfall statistics for Kilinochchi, Irrigation, at 80 feet above mean sea level illustrate the conditions in the area. The station records a moderately high mean annual total of 58.40 inches.

MEAN MONTHLY RAINFALL AT KILINOCHCHI, IRRIGATION (inches).

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
5.75	1.73	2.10	2.83	2.41	0.60	1.59	1.20	2.41	8.63	17.74	14.37

Source: *Report on the Colombo Observatory, 1957.*

The table shows that the wet season extends from October to January. The 'little monsoon' (which occurs just before the south west monsoon) rains are confined to the months from February to May. The dry season is from June to August.

The original natural vegetation of this area would have been dry mixed evergreen forests.*

THE GROWTH AND DECAY OF EARLY SETTLEMENTS

This area forms a part of the territory referred to as the *Vanni*, which was under the Sinhalese kings till the 14th century. The numerous abandoned tanks testify to the settlements and agricultural prosperity of this area during this time. In the wake of the Tamil invasions during the thirteenth century this area together with the rest of the Dry Zone fell into decay. Fig. 2 showing the settlements

* C. H. Holmes: The Climate and Vegetation of the Dry Zone of Ceylon, **Bulletin of the Ceylon Geographical Society** Vol. VI June 1951, pages 145—53.

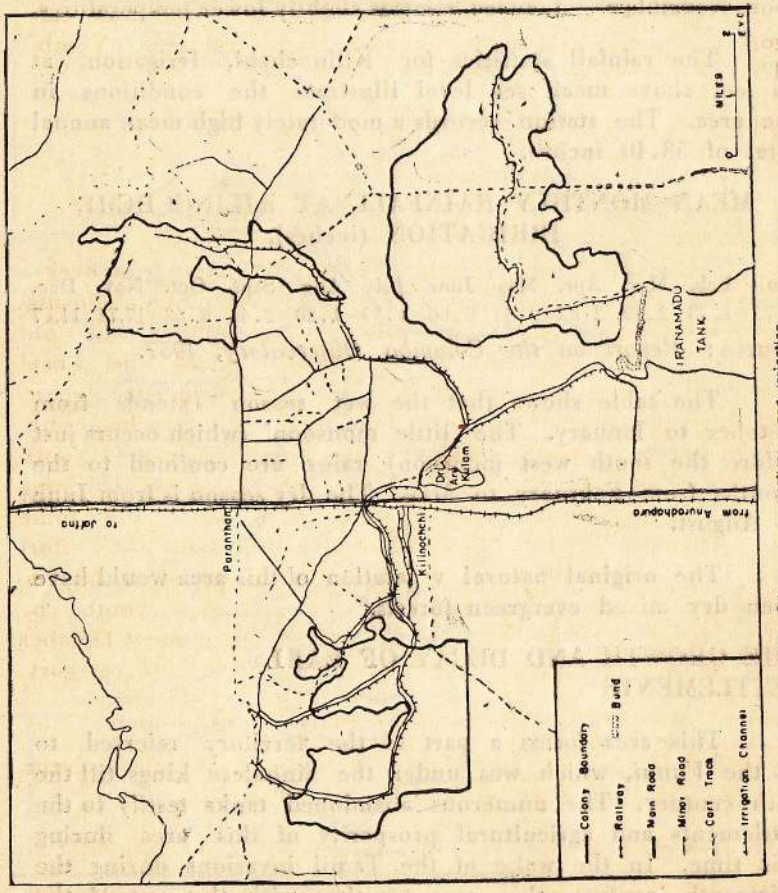

Fig. 2 Karachchi - Iranamadu Colony, communications and irrigation

of the few *Vanniyars*, who practised cultivation with uncertain results, tanks and irrigation channels, in use and abandoned, areas cultivated with irrigation facilities and communications gives a useful impression of the state of this area, before the establishment of this settlement scheme.

PRESENT SETTLEMENT

Selection and Source Regions of Allottees

The allottees of this colony belong to the four categories: Immigrant, Local, Labourers and Educated Youth.* Their distribution in 1953 is shown below:

Immigrant	564
Local	77
Labourer	15
Total	656

The immigrant category consisted of people from over—crowded and land — hungry villages of the Jaffna peninsula. Land-less peasants and those with little land in the old villages of this area received allotments under the Local category. Labourers in the service of Government departments responsible for the establishment of this scheme too obtained lands in the colony. The category, Educated Youth is a special feature of this colony. The allottees are young men with a good secondary education in Tamil and some in English as well. Their settlement represents an effort by the Government to ease the growing problem of unemployment among the ranks of the educated youth, by attracting them to the land. At the time of this inquiry, October — November 1960, there were 227 allottees in this category.

Social and Economic Background of the Colonists.

Some data on the background of 26 allottees interviewed by the writer are shown in Table 1.

Occupation.

14 allottees practised cultivation as a primary occupation, two allottees practised it as a secondary occupation while

* For a discussion of the methods of selecting peasant allottees, currently in practice see, B. H. Farmer, **Pioneer Peasant Colonisation in Ceylon**, Oxford University Press, 1957, page 201—7.

TABLE 1. DATE ON 26 COLONISTS INTERVIEWED

CATEGORY	No.	COMMUNITY	No.	RELIGION	No.	CASTE	No.	ORIGINAL SIZE OF FAMILY: No. of members in family	ORIGINAL SIZE OF FAMILY: No. of families	SIZE OF FAMILY IN 1960: No. of members in family	SIZE OF FAMILY IN 1960: No. of families
Immigrant	16	Jaffna Tamils	25	Hinduism	25	Vellala	15	1	10	1	4
Educated Youth	10	Muslims	1	Islam	1	Muslim	1	2	–	2	1
								3	–	3	3
								4	2	4	2
								5	2	5	2
								6	2	5	3
								7	6	7	5
								8	3	8	3
								9	–	9	–
								10	1	10	3

the remaining ten, who belonged to the Educated Youth category did not possess an agricultural background. Almost all the 16 agriculturists cultivated paddy and vegetables, while twelve cultivated tobacco and eight dry grains.

Land Ownership and Tenure.

Of the colonists interviewed, only five people owned land previously, the rest being landless. Only one allottee owned paddy-land the other four owned only garden - land. The size of the paddy and garden - land holdings varied from very small extents to ten *larchams.** Ten allottees practised share — cropping or *ande*, eight cultivated paddy - land and two garden - land. Three allottees leased paddy - land, while six leased garden - land. The paddy holdings on *ande* varied from ten perches to eight acres, while those on lease varied from one tenth of an acre to ten acres. The garden - land holdings on *ande* and lease were much smaller in size than the paddy holdings.

Agricultural traditions.

Out of the 15 allottees who cultivated paddy, five allottees cultivated two seasons of the year: *Kalapokam* and *Sirupokam.* § The remaining ten allottees cultivated only during *Kalapokam*. A *Sirupokam* crop was not possible on account of shortages of water. Paddy cultivation was based on north - east monsoon rains.

The simple wooden plough drawn by a pair of bullocks was the most common implement used in preliminary tillage in paddy cultivation, while traditional or unselected varieties of seed paddy were used by everyone. Transplanting was practised by nine allottees, weeding by twelve, organic manure was used by 15 allottees and artificial fertiliser by seven.

Production and Income.

Figures in respect of the *Kalapokam* paddy crop, reaped last by the allottees show that the yields of paddy varied from about ten bushels per bushel sown to a little over

* 24 larchams are equivalent to one acre paddy land and 16 larchams to one acre, garden land.

§ Kalapokam is the equivalent of Maha in this area and Sirupokam of Yala.

26 bushels. It was possible to obtain information with regard to the *Sirupokam* crop only from three allottees and they obtained 20, 35 and 12 bushels per bushel sown. Annual income obtained from the sale of paddy varied much, from small amounts to Rs. 1000. 12 allottees obtained incomes from subsidiary crops and their incomes were in the range of about Rs. 200 — Rs. 1000. 16 allottees obtained incomes from non — agricultural sources. The agricultural labourers were daily paid at rates 75 cents — Rs. 3.50. As their work was not regular, it was not possible to ascertain their incomes on an annual or monthly basis. Of the other ten allottees, five obtained monthly incomes of Rs. 20 — 150 and the remaining five annual incomes of Rs. 100 — 900.

LAND USE

The bulk of the land within the colony falls into the two major categories: low - land and high - land (Fig. 3). Local relief and slope in so far as they affected the lay out of the irrigation channel system were the dominant factors that determined the land classification. In view of the absence of information on the soils of this area, the influence of soils on land classification cannot be shown. The presence of jungle close to most parts of the colony, compensated for lack of forest reservations within the area. The extents provided as pasture were insufficient and of little use to the allottees.

AGRICULTURE

Type of cultivation practised on the low - land high - land allotments differed.

Low - land cultivation.

The construction of the Iranamadu tank was completed in 1937. The water of the Kanakarayan *aru* is impounded to form this storage reservoir. It has a bund 9,900 feet long, with a surface area of 5,750 acres and a capacity of 82,000 acre feet (Fig. 4). This tank is capable of irrigating 20,000 acres. Irrigation water is provided during *Kalapokam* to cultivate the full extent of the low - land allotments, but during *Sirupokam* the supply of water is restricted. The tank has two main sluices and water is distributed by means of two main distributary channels. One of these channels carries

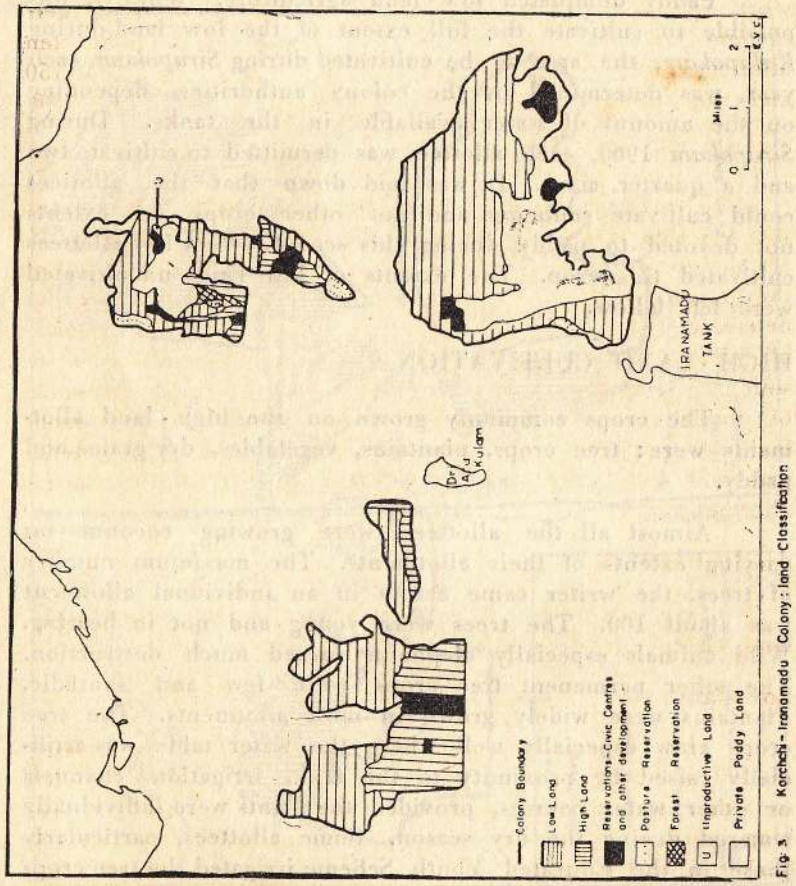

Fig. 3. Karachi - Iranamadu Colony : land Classification

the water into the Dri - *aru* tank, which had been formed by the restoration of an ancient bund, one mile in length, across a small valley about one and a half miles to the west of the Kanakarayan *aru*, from which water is distributed by two main channels. Wells in the high - land allotments are a source of supplying irrigation water to the crops grown there, during *Sirupokam*.

Paddy dominated low - land agriculture. While it was possible to cultivate the full extent of the low land during *Kalapokam*, the area to be cultivated during *Sirupokam*, each year, was determined by the colony authorities, depending on the amount of water available in the tanks. During *Sirupokam* 1960, each allottee was permitted to cultivate two and a quarter acres. It was laid down that the allottees could cultivate sunhemp and not other crops on extents not devoted to paddy during this season. Very few allottees cultivated this crop. The extents of low land uncultivated were left fallow.

HIGH - LAND CULTIVATION

The crops commonly grown on the high - land allotments were: tree crops, plantains, vegetables, dry grains and paddy.

Almost all the allottees were growing coconut on varying extents of their allotments. The maximum number of trees, the writer came across in an individual allotment was about 100. The trees were young and not in bearing. Wild animals especially elephants caused much destruction. The other permanent tree crops were few and sporadic. Plantains were widely grown in most allotments. The tree crops grew especially well where the water table was artificially raised by proximity to the tank, irrigation channels or other water courses, provided the plants were individually watered during the dry season. Some allottees, particularly those in the Educated Youth Scheme irrigated the tree crops from their wells, during the dry season.

Paddy, Vegetables, particularly chillie and onion, yams, cigarette and cigar tobacco and dry grains were cultivated during *Kalapokam* in plots of varying size; onion, chillie, dry grains, gingelly in particular were grown during *Sirupokam*

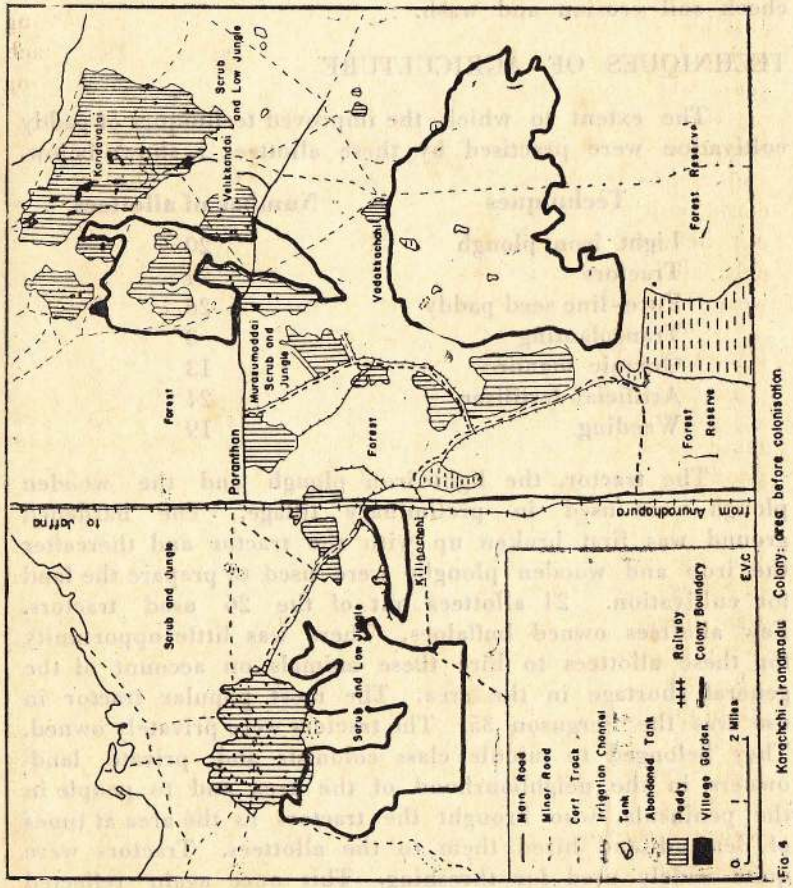

Fig 4 Karachchi - Iranamadu Colony: area before colonisation

under well irrigation. A rotation of crops was not practised, but these allottees had evolved a well planned out system of rotating the different plots devoted to these crops with each other and also with the area set apart each season for the use of animals. It was found that most high-land allotments were developed. This could be attributed to the industrious nature of the Jaffna Tamils and well irrigation which ensures cultivation during *Sirupokam*. Contour bunds and drains were put up and were regularly maintained to check soil erosion and wash.

TECHNIQUES OF AGRICULTURE

The extent to which the improved techniques of paddy cultivation were practised by these allottees is shown below.

Techniques	Number of allottees
Light iron plough	20
Tractors	24
Pure-line seed paddy	26
Transplanting	3
Organic manure	13
Artificial fertiliser	24
Weeding	19

The tractor, the light iron plough and the wooden plough were used in preliminary tillage. The hardened ground was first broken up with the tractor and thereafter the iron and wooden ploughs were used to prepare the land for cultivation. 24 allottees out of the 26 used tractors. Few allottees owned buffaloes. There was little opportunity for these allottees to hire these animals on account of the general shortage in the area. The most popular tractor in use was the Ferguson 35. The tractors were privately owned. They belonged to middle class colonists and private land-owners in the neighbourhood of the area and to people in the peninsula, who brought the tractors to the area at times of demand and hired them to the allottees. Tractors were quite widely used for threshing. This once again reflected the general shortage of buffaloes in the area.

The pure-line seed used here was propagated from stocks obtained from the Department of Agriculture some time back.

The following varieties were most widely in use:

Kalapokam		Sirupokam	
Murungakayan Vella ilankaliyan	4 months	Pachchaiperumal Seenati	3 months
Pachchaiperumal	– 3 months		

During *Kalapokam*, the four months varieties of paddy were sown dry and the irrigation water was let in after the germination of the seed, about four weeks after sowing. Sowing was usually done with the early north-east monsoon showers. The allottees who were late to prepare their fields cultivated the three months variety of paddy which was sown on flooded fields.

The limited practice of transplanting was due to: 1 — high labour costs, trained labour had to be obtained from the peninsula, 2 — the late issue of water during *Kalapokam* and 3 — insufficiency of time during the shorter *Sirupokam*. The four allottees had practised transplanting during *Sirupokam* on very small extents of their allotments.

Of the 13 allottees who did not use organic manure, 11 applied artificial fertiliser to the fields. Types of organic manure used were: compost, green manures and farm-yard manure. Penning animals in fields after harvest was a common practice of manuring and the position of the pen was shifted daily or once in two days, so that in due course the entire field is manured.

Weeding was done mostly by spraying weedicides. Only a few allottees did hand weeding. This was due to the insufficiency of family labour and the heavy expenditure for hiring labour. Spraying could not eradicate certain types of weed.

Improved methods of cultivation were practised on the high-land as well. High-land crops were heavily manured with compost, farm yard manure and green manures. *Kurakkan* was transplanted. Hand weeding was practised.

AGRICULTURAL PRODUCTION

Statistics of yields of paddy in the low-land for *Kalapokam* 1959 and *Sirupokam* 1960 reveal that about 50

per cent of these allottees secured medium to good yields varying from 26 to 50 bushels per acre during these two seasons. These yields reflected the full scale manuring done by these allottees. Perhaps their yields would have been higher if the other improved methods such as transplanting and better weeding were practised. However these allottees as well as the others who obtained poor yields attributed the state of their yields to certain inherent problems of their allotments: 1— undulating and uneven character of some areas, which greatly reduced the water retention property, 2— infertile sandy and gravelly soils, 3— salinity and alkalinity and 4— excessive weed growth. These allottees had been cultivating their lands for about eight years. It was found that in the case of ten allottees, the yields were progressively increasing, a tendency attributed to the fact that the lands were developed and manured. 12 allottees said their yields were declining due to the diminution of the initial fertility of the land with time. In the case of four allottees there had been no changes in the yields. It was not possible to obtain information with regard to the yields of high-land paddy and subsidiary crops.

INCOME

The sale of paddy constituted the principal source of the allottees' income. Estimates of gross income for *Kalapokam* 1959 and *Sirupokam*, 1960 reveal that most of the allottees secured incomes within the two groups rupees 501 — 1000 and less than 500. These incomes reflect the yields of paddy, since as in the earlier colonies, the major portion of the harvest was sold. These allottees' estimates of expenditure in connection with paddy cultivation were in the range of Rs. 223 — 1000 for the three acre allotment for each season. In the light of the writer's estimate of Rs. 300 for the allotment per season, the majority of these allottees obtained meagre to poor incomes.

Estimates of income from the sale of subsidiary crops for 1959 show that while eight allottees did not obtain any income, the remaining 16 allottees secured incomes varying from small amounts to about Rs. 500.

Five allottees obtained incomes from non-agricultural sources varying from Rs. 75 to Rs. 20000 per year.

TRANSPORT AND COMMUNICATIONS

The colony is served by the main Anuradhapura Jaffna road and the northern line railway from Colombo to Jaffna (Fig. 4). The Ceylon Transport Board operates buses at quite frequent intervals on the Jaffna — Anuradhapura road between Jaffna and Kilinochchi, Mankulam, Vavuniya and Anuradhapura in both directions. Two railway stations serve the colony: Paranthan and Kilinochchi. The railway is single tracked and there are four passenger trains a day in either direction between Jaffna and Colombo.

The principal lines of communication within the area are minor roads and cart tracks. Half-bullock carts were used as a mode of conveyance for the allottees and their families in addition to their use to transport paddy and other goods. The bicycle was a popular mode of conveyance among the men. During the wet season, some roads and cart tracks became impassable and some parts of the colony could be approached from Kilinochchi and Paranthan only by highly round about routes, many miles longer than the normal way.

MARKETING

These allottees sold their paddy to the co-operatives at the Government Guaranteed Price of Rs. 12 per bushel and at lower rates than this, to traders within the colony and in the neighbourhood and rich private land owners in the neighbourhood. Drawbacks in the actual working of the Guaranteed Price Scheme, as dishonest officers attempting to harass allottees with a view to obtain illegal gratifications, and delays in payment due to Government routine and red tape, forced people to sell their paddy outside the co-operatives for less than the Guaranteed Price.

The allottees' surplus of vegetables, chiefly chillie and onions and plantains was mainly sold in the weekly fair, held on Thursday in Kilinochchi. Fair prices were obtained. There were facilities to transport these commodities to areas of demand: Jaffna, Vavuniya and Anuradhapura. The single problem that the allottees were confronted with in marketing these commodities was transport costs. This was quite high in the case of people who lived in parts of the colony further

away from Kilinochchi. This problem was particularly felt during the rainy season when roads and tracks became so muddy that it becomes very difficult for the half-bullock carts to operate. Tobacco and the surplus dry grains were similarly sold.

CREDIT AND INDEBTEDNESS

The chief sources of credit of these allottees were the co-operatives and friends and relations in Jaffna. Unlike in several other colonies, traders did not function as a significant source of credit here. Many allottees said traders were generally unwilling to lend cash or even to sell provisions on credit.

25 allottees were indebted to the co-operatives. The debts of 50 percent of these people fall into the groups rupees 100—200, 201—300 and 301—400. 16 allottees were indebted to friends and relatives and the extent of their indebtedness was much higher than the debts owed by allottees to co-operatives.

A few allottees were in debt to some sources other than those indicated above. A loan of Rs. 1000 from traders had been drawn by one allottee to meet expenditure in connection with his wedding and he was paying an interest of 12 per cent on it. Two other loans Rs. 300 and 150 from this source were in respect of the purchase of provisions. Loans from fellow colonists and pawn brokers were taken for cultivation. These debts were in the range of rupees 300 to 500. The fellow colonists did nol charge any interest. The pawn broker's rate of interest was ten percent. The amount lent by the pawn broker was only a frrction of the value of the articles pawned. These became his property, if not redeemed within a specified period of time.

PROBLEMS AND OUTLOOK OF THE ALLOTTEES

14 allottees out of the 26 had families of six and over. The increase of family size in the colony was quite small. This was because all the 26 allottees obtained lands in the colony in 1955 and after, and the Educated Youth allottees were unmarried at the time of selection. The meagre to poor incomes secured by the majority of the allottees provided

only a low living standard. Allottees with large families suffered most. The people here except a few were poverty stricken.

The people in the colony were in favour of the prevailing system of land tenure. Many of them felt that the taxes were too high, when compared to the returns from the land. Due to their low incomes, many people found it difficult to pay the annual land tax of Rs. 50. According to the Land Development Ordinance 1935, the allottee could not lease, mortgage or sell his land. Leasing of allotments and *ande* were a common thing. The factors responsible were: 1— ill health, 2— financial stringencies, 3— dislike to live in the colony and 4— educated youth allottees getting Government employment.

Caste differences were vital in the social life of these allottees. *Vellala* allottees never visited the untouchables in their houses. There was no inter — marriage between people of different castes. Low - caste allottees were never elected to office in rural development or co-operative societies. However it was found that in public institutions such as schools and on public platforms these differences did not persist.

Ties with the original villages were strong. Some people practised garden cultivation in their villages. This practice of maintaining garden lands in the original village is a source of substantial income, for the garden crops command a good market. Unfortunately it was not possible to give any details about that income, owing to the reluctance of the allottees to speak on this matter. Marriages were usually contracted from the original villages. Some allottees had leased their lands and were living in the villages. Almost all allottees never failed to be present at festivals in the village *Kovil*. In fact many considered the village as their home and the colony a place where they possessed land.

Absence of sufficient pasture land was a serious problem that faced these allottees. Bad roads especially during the wet season, caused much difficulty in transporting the sick to the Kilinochchi hospital, as the rural hospitals within the area were ill equipped to tackle serious cases.

CONCLUSION

The poverty of these allottees can be expected to increase unless steps are taken to, improve their paddy yields, provided better facilities for marketing subsidiary crops and improve the internal communication system, and make available better credit facilities.

FRUIT CULTURE IN CEYLON — POTENTIALS AND POSSIBILITIES.

Y. D. A. SENANAYAKE

CEYLON has been described by agriculturists and non-agriculturists as a 'horticultural paradise'. The luxuriant natural, tropical vegetation, the availability of a wide variety of fruits, vegetables, flowers and ornamental foliage plants and the presence of suitable ecological conditions ranging from the tropical to sub-temperate are the main reasons for the identity. However, horticultural development on an organised system of culture, processing and marketing is still lacking and is a long felt need for diversifying our crop production.

The only group of horticultural crops which has received a little attention in the past is vegetables. This is because vegetables as a group form an important constituent of the average diet of our people and the daily demand is high. In order to meet this demand the culture of vegetables is more extensive and range from well cared plantings to small ill attended village plots. On the other hand, fruit culture received very little attention and encouragement, and production on a commercial scale comparable to the orchards of the horticulturally developed countries is still lacking. The richer foreign and local investors were mainly interested in the expansion and development of the traditional plantation crops like tea, rubber and coconut. It is clear that the future expansion of the plantation crops is becoming limited due to the increasing costs of production and lower returns due to competition from various sources.

The present economic crisis resulting from the continued high cost of importing and subsidising rice, coupled with the reduction of export earnings from the traditional plantation

crops has magnified the need for *new crops** in order to diversify agricultural investment with the hope of saving foreign exchange through substitution of imported products and earning foreign exchange through the export of such crop and crop products. In order to achieve this the prospective investor should know the potentialities of 'new crops' and the possibilities of producing them. An individual grower or an organisation will enter and stay in an agricultural venture only for the purpose of making money and if they are unaware of the 'potentialities and possibilities' they will not be interested in long term investments. This paper shows the 'potentialities and possibilities' of 'new crops' which could contribute to raise the agricultural wealth of this country.

THE POTENTIALS

The first fact that a prospective grower wishes to know is the current value of the local market and the future growth opportunities in the local and foreign markets. This information will give an estimate of the amount of money that is spent by the consumer on the different categories of fruits and fruit products. Unfortunately figures on either local production or their values are not known. This information is a long felt need and should be available for future planning. However the values for fruit imports and exports and the production figures of the largest and till recently the only canning factory are available. (Tables 1, 2, 3). They are used to illustrate certain trends.

The annual import and export values (1) of the more important fresh fruits and processed fruits for a 10 year period 1956 — 1965 are presented in table 1 and 2. The following observations could be made from these tables.

(1) The minimum average annual value for the importing years was about Rs. 10 million (m) rupees. This is a biassed estimate because some imports were gradually restricted from 1961 in order to conserve foreign exchange.

* The term 'new crops' is used here for crops which have the potentiality of being new with respect to an increase in agricultural wealth through organised culture, processing and marketing. Such crops may be old in the same sense in other countries or even in respect to ecological adaptability in Ceylon.

The reduction is particularly striking for the categories of fresh fruits and the processed forms. Therefore the true annual value should have been higher under normal free trading conditions. The average exports were worth about Rs. 2 (m) and was almost entirely the value of white and brown papain. The total import — export market was therefore worth 12 m rupees. This value is only a small fraction of the true value because the value of local fresh fruits, processed and preserved fruits and fruit products are not known and should be added to the above minimal value. Therefore it is apparent, that a sizable consumer market exists even if a fraction of the fruit value is exploited by fruit growers.

(2) Many products are derived from fruit species which are adapted to temperate growing conditions. The possibility of commercial cultivation of some such fruits is limited. Yet the possibility of substituting tropical fruits for similar uses is not remote.

(3) The continued high import values for certain items like dates is due to bilateral trade agreements which were made to stabilise adverse trade balances with countries importing our main export crops like tea.

(4) The fluctuations in exports were mostly due to vagaries of production caused by unforseen factors, high production costs which is unfavourable for foreign competition (2) and poor processing and marketing.

The reduction of the import of fruits and fruit products during the latter part of this period would suggest that the consumer had to switch to local substitutes and the demand for them should have increased. This should be reflected in the price of fresh fruits and in the availability of local products in our markets. The high price of fresh fruits in the market even during the season and the presence of innumerable brands of processed products on the retail shelves are suggestive that these conditions are present. The cessation of exports of processed fruits after 1961 (Table 2) and the increased number and types of products processed at the Marketing Department Canning Factory during the same period (Table 3) shows that local substitution has occurred.

A comparison of the import values of "preserves and preperations" for the two five year periods 1956 — 1960 and 1961 — 1965 respectively shows that a 90% reduction occurred during the second period (Table 1). The value of the processed products of the canning factory were not available. But if we represent the average unit value as x, then the average value of the processed products during the period 1956/57 to 1960/61 is approximately 482,000 x and during the 1961/62 to 1964/65 is about 1,133,000 x which is an increase of about 651,000 x. This means that the value increased by about 135% primarily due to the expanding substitution market. The increased value is only a fraction of the true increase. The values for increased production and the introduction of new brands by the private producers are not known. Therefore even through the export market dwindled the rising demand in the local market has helped to maintain increased production of a variety of local processed products.

Fruit culture is a long term investment and prospective investors will logically question whether the increasing demand shown in recent years would continue and give adequate returns in the future. The following facts should clear such doubts.

(a) **Population:**— The annual population increase in Ceylon is about 2.9% *ie.* an annual increase of approximately 300,000 heads. If an individual invests in an fruit orchard in 1967, in five years time when his orchard is begining to yield returns, the consumptive population would have increased by 1.5 million people. Similarly the world population will also show the same increase. Such population increases will accellerate with the years and fruits and fruit products will be increasingly needed locally and abroad as supplementary foods for a bursting population.

(b) **Space:**— The increase in the population and its concentration in urban areas will cause pressure on the available land. The swollen dwelling units will increase in such areas and as a result the traditional home gardens will gradually decrease thereby reducing the land area which was available for the establishment of a few fruit trees. This will cause a greater pressure on the retail marketing organisations which could only be supplied in quantity by large scale fruit culture.

TABLE 1. Quantity and value of fresh fruits,

ITEM	1956		1957		19
	cwt.	Rs.	cwt.	Rs.	cwt.
Fresh Fruits					
Citrus spp. (oranges, tangerines, mandarines etc.)	.2	10	.5	37	.1
Apples	19.0	1232	15.5	1200	16.5
Grapes	13.3	1947	15.0	2051	15.8
Others (berries, olives etc.)	.6	10	.06	4	.2
Edible nuts and seeds	.25	74	.25	64	.35
Dried Fruits					
Raisins	4.4	336	3.5	106	1.0
Sultanas	7.0	538	8.7	702	11.2
Currants	1.8	139	2.1	162	2.2
Dates	53.4	856	44.6	897	70.0
Tamarind	77	1753	42.2	962	73.3
Others	.15	28	.15	28	.4
Preserves & Preservations					
Canned and Bottled Fruits	3.3	361	3.7	446	3.7
Jams and Jellies	11.7	1007	16.5	1482	18.8
Juices (Fruits and Vegetables)	.2	23	.3	30	.2
Cordials	1.2	81	2.0	112	.7

a. A few items of low value are omitted from this

b. There is no breakdown for fruits and vegetables

c. The value is exceedingly high compared to the a

TABLE 2. Quantity and value of proces

ITEM	1956		1957		19
	cwt.	Rs.	cwt.	Rs.	cwt.
Processed fruits	6.7	450	6.5	437	.2
Papain	1.7	2274	2.3	3793	1.4

Quantity and value of fresh fruits, dried fruits and processed forms imported during a 10-year period, 1956—1965

(Each whole-number represents 1,000 units)

	1956		1957		1958		1959		1960		1961		1962		1963		1964		1965		Average for importing years	
	cwt.	Rs.	cwt.	Rs.	cwt.	Rs.	cwt.	Rs.	cwt.	Rs.	cwt.	Rs.	cwt.	Rs.	cwt.	Rs.	cwt.	Rs.	cwt.	Rs.	cwt.	Rs.
	.2	10	.5	37	.1	7	.25	17	.3	22	.35	20	1.75	125	—	—	—	—	—	—	.49	34
darines etc.)	19.0	1232	15.5	1200	16.5	1161	21.5	1375	35.0	1186	7.0	397	—	—	—	—	—	—	—	—	19	1092
	13.3	1947	15.0	2051	15.8	1850	24.8	2659	32.5	3516	.2	38	—	—	—	—	—	—	—	—	16.9	2010
	.6	10	.06	4	.2	9	.05	3	.2	14	.03	7	.4	26	—	—	—	—	—	—	.25	12
eeds	.25	74	.25	64	.35	71	.7	124	.45	99	.55	140	.4	85	.55	141	.1	33	—	—	.40	92
	4.4	336	3.5	106	1.0	56	2.3	162	1.6	98	5.2	483	2.1	121	.35	17	.46	60	.8	50	2.2	149
	7.0	538	8.7	702	11.2	924	11.4	1015	7.6	644	2.5	215	18.3	717	9.8	704	6.1	507	—	—	9.2	663
	1.8	139	2.1	162	2.2	175	3.6	305	3.3	265	4.1	339	4.0	333	3.2	260	3.7	342	8.7	833	3.7	315
	53.4	856	44.6	897	70.0	927	81.9	1250	86.4	1342	126	2137	210	3160	208	2806	233	4121	207	4453	132	2194
	77	1753	42.2	962	73.3	1657	79.6	2578	101	2813	13	376	35.6	798	45.2	983	44.6	1226	24.6	732	54	1390
	.15	28	.15	28	.4	57	.3	32	.3	47	.5	65	1.2	109	.85	113	.1	15	—	—	.4	55
vations																						
ed Fruits	3.3	361	3.7	446	3.7	455	4.6	508	4.4	516	1.8	202	.7	90	—	—	.02	4	—	—	2.8	322
	11.7	1007	16.5	1482	18.8	1762	12.0	1162	19.0	1623	10.8	920	1.7	154	—	—	.02	3	—	—	1.3	1014
Vegetables)	.2	23	.3	30	.2	22	.3	35	.2	31	.01	25	.1	21	.35	66	.14	28	1.6	943[c]	.34	122
	1.2	81	2.0	112	.7	61	1.4	79	1.4	39	.15	7	—	—	—	—	—	—	—	—	4.14	63

items of low value are omitted from this table.

is no breakdown for fruits and vegetables in the references.

lue is exceedingly high compared to the average values for previous years. It may be an error or an exchange irregularity.

Quantity and value of processed fruits and fruit products exported during a 10-year period 1956—1965

(Each whole number represents 1000 units.)

	1956		1957		1958		1959		1960		1961		1962		1963		1964		1965		Average for exporting years	
	cwt.	Rs.	cwt.	Rs.	cwt.	Rs.	cwt.	Rs.	cwt.	Rs.	cwt.	Rs.	cwt.	Rs.	cwt.	Rs.	cwt.	Rs.	cwt.	Rs.	cwt.	Rs.
	6.7	450	6.5	437	.2	17	1.1	59	6.3	296	.4	23	—	—	—	—	—	—	—	—	3.5	214
	1.7	2274	2.3	3793	1.4	2779	2.7	2973	2.1	1711	.7	631	.6	747	1.0	1738	1.6	1844	1.3	2002	1.5	2029

TABLE 3

Number of units of processed fruits and vegetables produced by the Marketing Department Canning Factory for a 9 year period.[1]

ITEM	NUMBER OF PRODUCTION UNITS[2]								
	56 – 57	57 – 58	58 – 59	59 – 60	60 – 61	61 – 62	62 – 63	63 – 64	64 – 65
Canned and Bottled Fruits (pieces, rings etc.)									
Pineapple	532959	299471	117708	149869	162087	286539	107169	188536	129229
Mango	—	—	1478	1763	2810	3128	17459	5056	35331
Pear	144	443	—	—	—	—	185	—	—
Cashew	—	—	—	—	6	—	—	—	2688
Jams and Jellies									
Pineapple	77284	42051	51713	199683	103058	51903	622810	239097	184010
Papaw	610	774	38579	17609	4934	39990	54778	56133	164749
Passion fruit	141	331	323	—	50	35568	48857	83269	56665
Woodapple	233	6526	16515	—	--	41246	217048	244107	209457
Tomato	—	—	5709	—	7254	3595	55448	77135	252240
Guava	—	—	—	—	—	1231	8125	19175	4004
Orange	—	—	—	—	—	—	15191	7765	—
Ambarella	—	—	—	72	—	—	—	521	—
Pumpkins (red and ash)	—	—	—	—	—	—	—	—	60155
Juices									
Pineapple	—	20160	126931	90302	69438	49743	—	94706	66923
Lime	—	2292	7346	17364	—	545	3572	9197	3125
Tomato	—	—	16930	—	6910	23796	—	15461	37385
Passion fruit	—	—	—	—	—	297	—	—	—
Cordials and Crushes									
Orange	22665	22888	42032	12335	50688	6603	34558	4819	48799
Passion fruit	7	—	622	797	7335	5314	10657	2228	7359
Lime	898	—	202	2184	435	501	101	725	1980
Grape fruit	—	—	—	—	2565	2295	2208	8137	11405
Pineapple	2244	1885	—	—	—	59452	—	—	—
Creams									
Belli	—	—	—	—	4654	8150	73328	2060	25470
Durian	—	—	—	—	839	24799	199	—	2055
Woodapple	—	—	—	—	—	6135	7666	46442	—
Pickles and Chutneys									
Mango	—	—	—	108	10674	179	—	985	9337
Lime	166	—	—	4559	3417	1017	—	—	—
Lemon	—	—	—	523	1059	—	—	—	—
Ambarella	—	—	—	—	1114	—	—	—	—
Sauce									
Tomato	—	—	—	1050	2839	13225	39110	81149	43600
Chillie	—	—	—	124	8284	—	5712	1331	—
Total No. Units/yr.	637351	396821	426119	498360	450652	664256	1323171	1188034	1355616

1. A few items of very limited production are not included in this table.
2. The units are mostly No. 2 and No. 2½ cans, bottles, ½ bottles and jars.

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(c) **Food Habits:—** In recent years the trend has been for the younger generation of the affluent countries to consume soft drinks made from fruits, synthetics and mixtures in preference to the traditional beverage drinks like tea, coffee cocoa etc. The proportion of the population comprising the younger age group increases each year and should give comfort to fruit growers.

(d) **Health:—** Fruits and fruit products are nutritious. While excessive consumption of other foods and beverages may be detrimental to health the consumption of fruits is beneficial and is essential in the average diet of humans. A large proportion of the population is aware of their value. The main factor which prevents an average consumer including fruits in the daily diet is the cost. This could be corrected only by adequate supply, which will be determined by production which again will be determined by the extent of investment on large scale fruit culture.

(e) **Variety:—** Unlike other crops, fruits can be offered to the consumer in. many forms (Fig. 1). If the fruit does not move in the fresh fruit market channels it could be channeled elsewhere for processing and offered during or after the season in one or more of the processed forms. Markets for such products could be developed locally and abroad. In addition to products of human consumption other products for industrial consumption are also obtained as by products of the fruit industry.

The above points suggest that a prospective investor should have good returns from fruit culture in the future. But if we examine the history of the development of "new crops" in other countries it is appearent that many factors could influence their success or failure. The possibilities of fruit culture discussed below includes the more important factors. Their significance may vary with each crop and the order of history is not necessarily the order of importance to all fruit crops. The most important factor, namely, the availability of markets was discussed. In addition to the available market, new markets will have to be found in order to offer new products in the processed, preserved and by product forms for human consumption and industrial uses.

THE POSSIBILITIES:

The possibilities of fruit culture is not new to this country. The majority of fruit trees grow under natural conditions with very little attention. But commercial fruit orchards are long term investments and the investors expect maximum profits from a unit area of land. To achieve this certain basic conditions should be available.

(a) Land and Climate

In order to establish organised fruit culture we should know whether suitable land is available and is suitable for diversified fruit culture. Fortunately, most introduced species and varieties of fruits have grown in Ceylon for a long time to give us an idea of their agroclimatic adaptability (Fig. 2). The figure shows that,

(i) All the commercially important fruits and others of lesser importance could be grown in the existing agroclimatic zones of Ceylon.

(ii) Certain fruit species are more adaptable to one agroclimatic zone than another.

(iii) About 50% of the fruits are adapted to the drier districts of Ceylon. The nature of the rainfall pattern in the drier regions is more suitable for fruit culture than the wet zone. The more important fruits are adaptable to this zone. Land is available in the dry zone and sufficient rainfall exists for perennial crop production even in the driest part of this agroclimatic zone. Countries with much less precipitation than the dry zone and with many problems associated with sub arid conditions have transformed parched land into green orchards. Therefore, the harnessing and distribution of water will be the limiting factor in Ceylon, rather than the agroclimatic adaptability or the availability of land.

(iv) Some types like *Citrus*, *Anonas* and mangoes have a wide distribution due to species specific or variety specific adaptability.

It is therefore clear that land and climatic conditions are available for the establishment of fruit orchards. The choice of a suitable site is influenced by certain factors

and due consideration should be given to them before a final decision is made. It has been observed in other countries that a grower usually utilises a poorer part of the farm for a new crop. Because of the poor returns on some of our traditional export crops there may be a tendency to change from the established crops of marginal estates to new crops and the same principle of using the poorer localities may be followed. Assessments from such areas will not give a production pattern. In addition, during the early stages of the development of a crop the most ideal area of production may not be definitely known and mistakes could occur through ignorance and unanticipated problems may arise.

(b) Available Types of Fruits.

A wide range of fruit species are adapted to the climatic conditions prevalent in Ceylon (Fig. 2). Some types are adapted to a broad zone while others do best in a narrow zone. Some fruits like the *Anonas* show specific adaptability and the expansion of the different species could be accomplished well within their respective climatic zones. Some others like mangoes show 'variety specific' adaptability *ie.* horticultural varieties have evolved to suit specific ecological conditions.

The early dicotyledenous fruit tree populations were almost entirely seedlings. Even today, the majority of the plants are seedlings. Such populations offer a wide gene pool from which selected types could be increased within each region of commercial cultivation by the use of vegetative propagation methods. Therefore, when popular varieties are not suitable for specific areas the horticulturist could substitute the existing types which are already adapted to such regions. Some types may not compare favourably with the better known varieties particularly if they fruit during the peak season. This may not be a problem because, if the quality is acceptable they could serve the processing industry. In the alternative, selections could be made from mother plants which show a history of good bearing during the off-season. Such types have a lesser competition and may give as good returns as the better varieties which bear during the normal fruiting season.

The genetic exploitation of fruits is a never ceasing challenge for fruit breeders. The recognition of new mutants and chimearas, hybridization and selections, artificially induced changes etc., for economically valuable horticultural characteristics are a few of the techniques which are used by fruit breeders to offer a better fruit to the consumer. Fortunately the populations of fruit trees in Ceylon offer a wide genetic base to improve the existing varieties to meet any kind of request by prospective growers.

(c) **Incentives and Services.**

A fruit orchard takes a few years to give returns. During this period the objective is to obtain maximum balanced vegetative growth. The grower has to incur a considerable expense during the vegetative phase of growth. Therefore the present tax holiday for five years is fruitless to a fruit grower. It would be advisable to have an extended tax holiday as a realistic incentive for fruit culture.

Maximum profits from fruit culture could be realised only if adequate processing facilities are available for the maximum utilization of the crop. Unless several private processing plants are available a grower can be exploited. This may result in unprofitable crops and the expansion of a "new crop" may cease. To prevent such a setback at the early stages the state may have to provide processing facilities. The possibility of introducing portable processing units may have to be explored. The provision of incentives and perhaps even a small subsidy plus the provision of services by the state should be considered as investments by the state because an organized and expanding fruit industry will create new employment opportunities for a large number of people in numerous areas such as production, marketing, processing, technical services etc. which is common to most industries.

Therefore an early attempt should be made to provide useful incentives for fruit culture, and this would no doubt yield dividends early, and will contribute to increasing and diversifying our agricultural economy, so that Ceylon could become more truly a 'horticultural paradise'.

ACKNOWLEDGEMENT

The author wishes to thank the Commissioner for the Development of Marketing for making available the production statistics of the canning Factory.

REFERENCES CITED.

1. Ceylon Custom Returns 1956 — 1965.
2. Annual Reports of the Commissioner for the Development of Marketing 1958 — 1962.

FIGURE 1. **Some of the consumptive and industrial products obtained from horticultural fruits.**

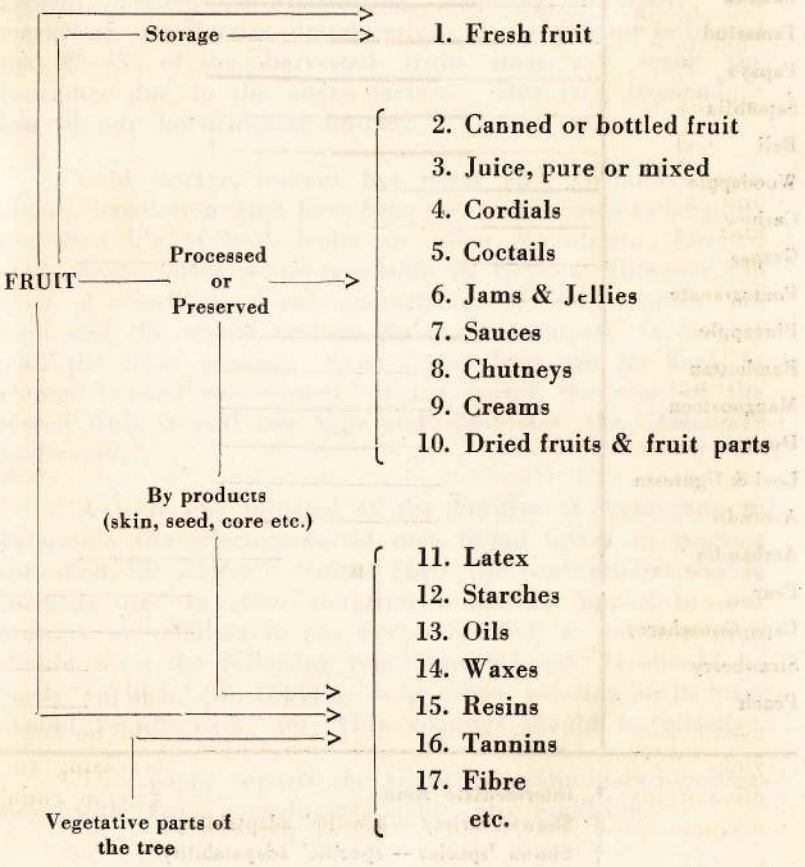
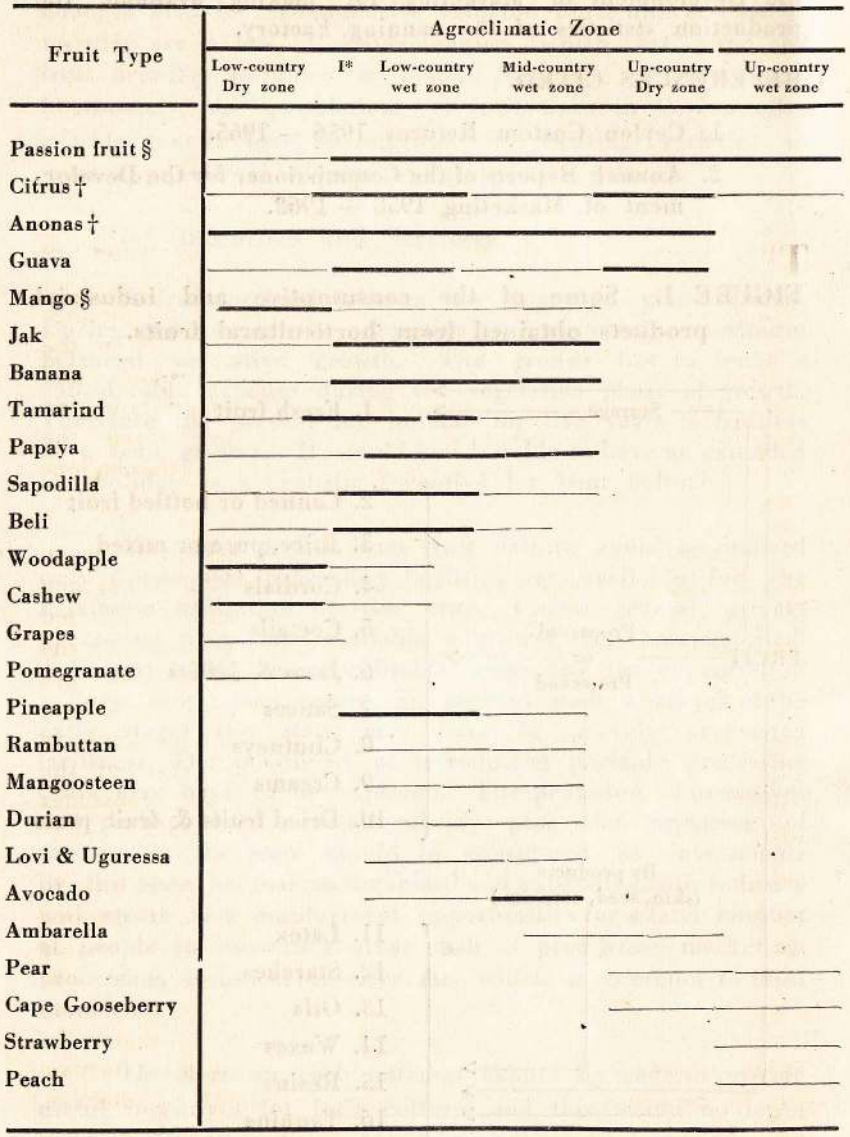


FIGURE 2. **Agroclimatic adaptability of fruits in Ceylon (Thicker bar indicates greater adaptability to zones).**



* Intermediate zone
§ Shows 'variety — specific' adaptability
† Shows 'species — specific' adapatability

'TAG' — A WAX EMULSION FOR EXTENDING THE SHELF LIFE OF FRESH FRUITS.

Y. D. A. SENANAYAKE

THE harvested fruit deteriorates due to the onset of physiological ripening processes and the occurrence of pathological storage diseases. The latter often accellerates the onset of senescence in harvested fruits. In Ceylon the present methods of harvesting, handling, transport and marketing accellerates deterioration. I is roughly estimated that 35–45% of the harvested fruits does not reach the consumer due to the above factors. This is a tremendous loss of our horticultural output.

Cold storage, waxing, hot water and chemical treatments, irradiation etc., have been successfully used to lengthen the shelf life of fresh fruits in other countries. Limited cold storage facilities are available in Ceylon. However, the costs of construction and maintenance of cold rooms are high and the stored product does not compete favourably with the fresh product. Even if the fruit can be kept in storage beyond the normal fruiting season the cost of the stored fruit is still too high and decreases the consumer preference.

A trial was initiated at the Faculty of Agriculture to determine the effectiveness of new liquid waxes to prolong the shelf life of fresh fruits. Since the conventional waxing methods used in other countries would not appeal to our growers or retailers it was necessary that a suitable wax should meet the following requirements. (a) It should be easily applied. (b) Dipping in a dilute solution or its foam should be effective. (c) Thin coatings should be effective.

This paper reports the results of preliminary investigations with Tag–a translucent, stable wax emulsion.

TREATMENT

The solution was made to foam with a mechnical stirrer. The amount of experimental liquid was small and therefore the foam was brushed on the fruit instead of immersing the fruits in the foam as suggested by the manufacturers. Four batches of fruits were tested.

Treatment 1, (T–1):— Tangerine fruits picked from a retail market. Twenty were treated the same day. The interval between harvest and treatment was two days.

Treatment 2, (T–2):— Tangerine fruits harvested from one tree. Twenty fruits were treated the following day. These fruits had a thicker skin than the fruits for T–1.

Treatment 3, (T–3):— Lime fruits harvested from one tree. Twenty five were treated the following day.

Treatment 4, (T–4):— Local pear fruits picked from a retail market. Twenty were treated the following day. The interval between harvest and treatment was 3 days.

Equal number of untreated fruits served as the control (C). Records of fruit weights, yellows and market rejects (Visual elimination as in retail markets) were taken every 4 days. The results are presented in Tables 1—4. The average laboratory temperature was 28.5° C and the relative humidity was 55%.

REDUCED WEIGHT LOSSES

The treated tangerine and lime fruits show a fairly uniform rate of weight loss. The control fruits of T–1 had a slightly higher weight loss than T–2. It may have been due to the differences in the origin of the two samples of fruits and the thinner rhinds of T–1. In all cases the weight loss of the treated fruits were less than the controls. Sometimes citrus fruits particularly the limes and lemons are sold by weight. In such instances the treated fruits should give higher returns to the retailer due to the reduced weight loss and also because more fruits could be sold from a lot due to the extended shelf life. Furthermore the treated fruits retain their glossy, attractive appearance which will be more appealing to the consumer than the untreated fruits. The treated pear fruits also had a lower rate of weight loss which helped to prolong their shelf life. Tag allows the fruits to continue respiration. Therefore the rapid water loss in the controls seem to initiate early senescence of the fruits.

REDUCED SENESCENCE

The controls of T–1, T–2 and T–3 yellowed and reached the stage of market rejection sooner than the treated fruits (Tables 1—3). For treated tangerines the number of additional days, before all the fruits yellowed ranged from 20 days in T–1 to 44 days in T–2 over that of the control. Rejections in T–1 took 32 days longer than the control and for T–2 it took 36 days (Fig 1). The slight difference in the two treatments may be attributed to the difference in origin of the two samples and the time interval between harvesting and waxing. One fruit yellowed early in T–2 (Table 2). It was due to a harvest injury in the rhind which apparently accellerated ripening. The fruits began to yellow at the stem end. The rate of yellowing and subsequent browning was more rapid in the control.

The shelf life of the treated lime fruits was also extended (Table 3). The fruits yellowed gradually. The control was in an unmarketable state in 20 days while the treated fruits were still attractive. The shelf life of the treated fruits was extended by 32 to 60 days.

The shelf life of pear too was doubled. However, breakdown due to soft rots was rapid. This was probably due to poor harvesting and rough handling before it reached the market. The early senescence of some citrus fruits was also due to the development of pathological conditions on the skin. Therefore careful harvesting and the use of a fungistat before the wax application could retard the early senescence of treated fruits.

These preliminary results suggest that the shelf life of citrus species could be extended by the application of suitable waxes thereby reducing the wastage caused by the current marketing practices. It is suggested that extensive trials should be undertaken by horticulturists to determine the use

of Tag and similar products on all fruits of economic importance in Ceylon. In addition to the extension of the shelf life, other aspects like quality, economics etc., should be investigated simultaneously before definite recommendations are made for any commercial product.

ACKNOWLEDGEMENT

The author wishes to thank Dr. Mervyn D. de Silva of A. Baur & Co. Ltd., for obtaining a sample of Tag from their principals abroad for the initiation of this study, and Mr. P. G. Gunaratne, Laboratory Assistant, Division of Agronomy for assistance during the investigation.

FIGURE 1. **Range of increased marketable days of treated Citrus fruits before 100% yellowing and rejection.**

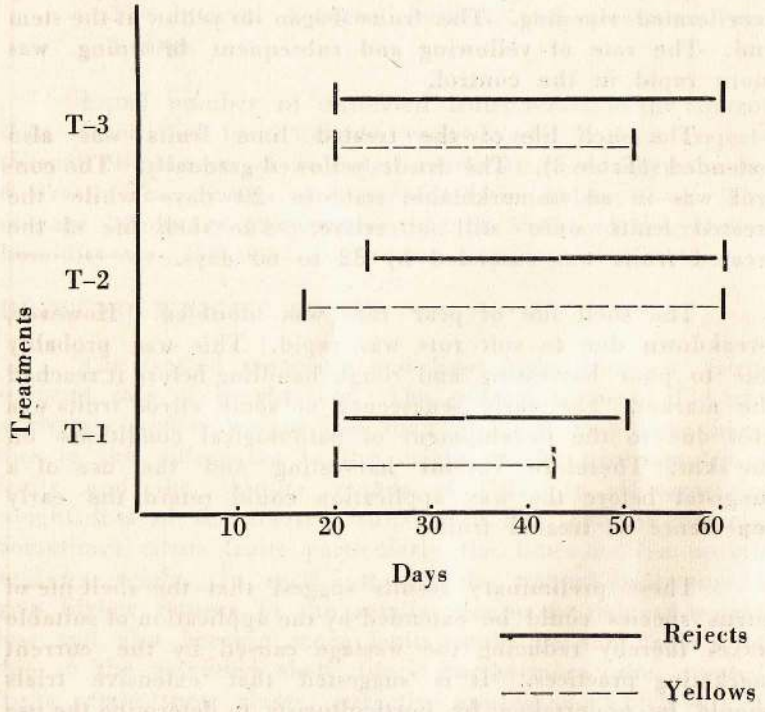


TABLE 1. **Reduced weight losses and delayed senescence of a sample of Tag treated tangerines (T-1).**

Days	Weight (gms).		% Weight Loss.		% Yellows			% Rejects	
	C	T-1	C	T-1	C	T-2		C	T-1
0	1021.1	1025.5	—	—	—	—		—	—
4	919.7	998.8	9.9	2.6	10	—		—	—
8	850.9	975.4	16.7	4.9	30	—		10	—
12	799.6	959.6	21.7	6.4	80	—		30	—
16	738.9	938.2	27.6	8.5	90	5		50	5
20	693.0	922.6	32.1	10.0	100	10		100	10
24	643.8	901.9	36.9	12.1		55			10
28	596.0	880.0	41.6	14.2		70			15
32	552.9	854.4	45.8	16.7		75			35
36	510.7	822.7	50.0	19.8		90			70
40	466.3	770.0	54.3	24.9		100			80
44	423.7	705.4	58.5	31.2					90
48	390.4	629.6	61.8	38.6					95
52	358.3	556.0	64.9	45.7					100

TABLE 2.

Reduced weight losses and delayed senescence of a sample of Tag treated tangerines (T-2).

Days	Weight (gms).		% Weight Loss		% Yellows		% Rejects	
	C	T-2	C	T-2	C	T-2	C	T-2
0	1264.0	1344.9	—	—	—	—	—	—
4	1161.0	1304.2	8.1	3.0	5	5	—	—
8	1106.2	1279.9	12.5	4.8	20	5	—	—
12	1041.8	1257.1	17.6	6.5	65	5	—	—
16	997.1	1238.7	21.1	7.9	100	10	5	—
20	948.7	1213.6	24.9	9.8		15	45	5
24	898.8	1181.3	28.8	12.2		15	100	10
28	854.2	1150.1	32.4	14.5		15		10
32	809.7	1118.2	35.9	16.9		25		20
36	788.2	1088.2	37.6	19.0		45		20
40	748.2	1048.5	40.8	22.0		60		35
44	709.8	1012.8	43.8	24.7		65		40
48	659.7	968.4	47.8	27.9		70		50
52	615.7	926.7	51.2	31.0		80		75
56	549.8	885.5	56.5	34.2		90		85
60	513.5	841.2	59.3	37.4		100		100

TABLE 3.

Reduced weight losses and delayed senescence of a sample of Tag treated limes (T-3).

Days	Weight (gms).		% Weight Loss		% Yellows		% Rejects	
	C	T-3	C	T-3	C	T-3	C	T-3
0	915.5	933.5	—	—	—	—	—	—
4	830.6	899.1	9.3	3.7	—	—	—	—
8	772.8	878.5	15.6	5.9	28	—	—	—
12	718.4	857.3	21.5	8.2	60	8	24	—
16	685.4	842.8	25.1	9.7	80	24	40	—
20	652.5	827.6	29.2	11.1	100	28	100	—
24	627.3	802.9	31.5	13.9		28		—
28	602.8	784.7	34.2	15.9		28		—
32	570.4	760.5	37.6	18.5		48		8
36	563.9	753.7	38.4	19.2		60		12
40	542.4	740.4	40.7	20.6		76		24
44	517.7	725.8	43.4	22.4		80		32
48	501.4	708.5	45.2	24.1		88		48
52	486.8	692.8	46.8	25.7		100		68
56	467.5	669.8	48.9	28.2				80
60	450.4	650.3	50.8	30.3				100

TABLE 4.

Reduced weight losses and delayed senescence of a sample of Tag treated pears (T–4)

Days	Weight (gms)		% Weight Loss		% Rejects	
	C	T–4	C	T–4	C	T–4
0	1569.0	1594.1	—	—	—	—
4	1466.0	1528.1	6.6	4.1	5	—
8	1353.1	1471.0	13.8	7.7	25	10
12	1246.6	1408.7	20.5	11.6	100	20
16	1135.4	1345.0	27.6	15.6		75
20	1061.4	1280.9	32.3	19.6		75
24	952.4	1189.9	39.2	25.3		100

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