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CONTENTS

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CONTENTS

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CREDIT SCHEMES AND PADDY CULTIVATION IN CEYLON.

J. M. GUNADASA

AGRICULTURAL credit has now been made a very significant item in the economic development plans of Ceylon. The magnitude of its role in the present development strategy is reflected in its growth over the years. There is sufficient information to trace the course of events with definite phase changes. The term agricultural credit here is used to mean the credit facilities for paddy cultivation.

During the period prior to 1947 the economy of Ceylon was controlled mainly by the British. The emphasis was on the development of the plantation crops. Paddy cultivation and the traditional economy was left to the conservative villagers. The development in this section can be identified mostly with the restoration of some irrigational works. Many other problems that the paddy cultivators as a functional group in the society had to face passed unnoticed. The government did not have a scheme of agricultural credit. This does not mean that the government did not create certain institutional facilities and opportunities for the fulfilment of the credit requirements of the cultivators. In this respect the service rendered by the co-operative movement cannot be overlooked. However, even such activity was not directed as a projected effort towards the development of paddy cultivation. The co-operative societies built up their own funds. But many societies were financially weak. The government granted loans to such societies from a fund known as Local Loans and Development Fund with a view to strengthening their finances. These organisations lent money to cultivators only for productive purposes. But in fact many loans were drawn by members even for non-productive purposes. Only a handful of cultivators became members of co-operative societies. Non members were not entitled to get

loans from these societies. There were no other public institutions which served the cultivators' needs.

The granting of agricultural credit on an organised scale was initiated by the government. The period of government organized credit may be divided into four phases. 1947 to 1957 is the first phase. The necessity to provide credit facilities to paddy cultivators was recognized. Certain institutional changes were effected. The changes that were introduced during this phase may be considered under three stages. The organization of the Co-operative Agricultural Production and Sales Societies in 1947 is the first stage. The government extended credit facilities to the cultivators through these societies. The credit was given both in cash and kind. The credit in cash was restricted only to the purchase of buffaloes for ploughing. All other credit — implements and fertilizers — was given in kind. The credit was granted from a fund administered by the Land Development Department. The department lent to the Co-operative Provincial Banks at ½% interest. The Banks in turn lent to Co-operative societies at 2% interest. The members had to pay 5% interest to societies for short term loans and 4% for long term loans. The quantum of loan a member could obtain was very small. The maximum amount of loan that a cultivator member was entitled to in 1944/45 was Rs. 60/-. By 1947/48 this amount was raised to about Rs. 75/-. In 1948 a total of Rs. 3,089,000/- had been loaned to the cultivators.(1) Although this was a good portion of the Food Production Fund of the Department of Land Development, only a small percentage of the cultivators benefited by this scheme. The recipients of the loans were only the members of the Co-operative Agricultural Production and Sales Societies. The membership was a negligible fraction of the total number of cultivators. The loans were meant to be utilized both for the increase of yield per acre and for the asweddumisation of new lands.

The year 1950/51 marked the second stage. The credit limit of an individual member was increased to Rs. 100/- The cash loans given for the purchase of buffaloes still

(1) Details relevent to this stage are extracted from the Administration Report on the Working of the Co-operative Societies. From May 1st 1945 to August 20th 1948. *By Edmund J. Cooray (July 1949).*

continued. There was no change in the previous scheme of granting the other loans in kind. These included agricultural implements, barbed wire, fertilizers and water pumps etc. In 1953 the total amount of loans given to cultivators was Rs. 13,000,000/-. All this was distributed through the Co-operative Agricultural Production and Sales Societies.

In 1955 the function of granting credit was taken away from the Land Development Department. It was now made the responsibility of the Director of Food Production. The few years from 1955 to about 1957/58 therefore may be considered a third stage. During this stage there was an intensification of the provision of facilities to the cultivators. By this time the Co-operative Agricultural Production and Sales Societies were organised in almost all the districts. Up to 1955 the total amount of loans received by societies was Rs. 74,700,000/-. According to the 1956 figures(2) the membership in the Co-operative Agricultural Production and Sales Societies was 235,000. The estimated number of cultivator families in the island at the time was about 800,000. Basing the calculation on these figures it was only 20% of the cultivators that became members of these societies. This was the period of highest activity in the CAP & S Society movement Co-operative Agricultural Production and Sales Societies rose to a maximum at the end of this stage as shown by the following table.

TABLE 1.

CAP & S SOCIETIES BY YEARS*

Year:	1947/48	48/49	49/50	50/51	51/52
Number:	47	140	275	337	498
Year:	52/53	53/54	54/55	55/56	56/57
Number:	709	779	842	955	995

The percentage of the cultivator population which made use of the credit facilities was even less than during the previous years.

(2) Report on the Ceylon Co-operative Movement 1956. *By P. E. Weeraman — Commissioner of Co-op. Devel. & Registrar of Co-op. Societies.*

* Extracted from the Reports on the Ceylon Co-operative Movement. *By CCD & RCS.*

The rate of progress up to 1957 therefore was not sufficient to keep pace with the worsening economic situation particularly among the agricultural population in the rural sector. The government planned to set up a network of smaller village level organisational units which could undertake several economic functions and also enable a large scale participation of the cultivators in village level programmes of the government. With this objective in mind a campaign was launched in 1957[3] to organise Multi-purpose Co-operative societies; at the beginning at the rate of one for a village but later one for two or more villages depending on economic viability. This is the second phase. Now the organization of the C A P & S societies was discouraged. Instead many societies were either liquidated or broken up into several M P C S societies (Multi-purpose Co-operative societies). Some societies were allowed to continue as C A P & S societies. This situation created a confused institutional set-up. Some more changes were introduced by the government. An entirely new department—the Agrarian Services Department —mainly to organise and improve paddy cultivation in Ceylon was set up on 1st October 1957.[4] A Paddy Lands Act was passed in 1958. A different type of village level institution called cultivation committees, was set up. Many of the schemes in respect of paddy cultivation were now operated through the new department in collaboration with other departments — mainly the Department of Co-operative Development and the Department of Agriculture. In granting loans the separation into loans in cash and loans in kind was maintained. The cash loans were given under two categories; (a) cultivation loans and (b) marketing loans. The former was granted to the societies to be distributed among the cultivator members. The latter was to strenghten the funds of the societies to purchase paddy under the Guaranteed Purchase Scheme.[5] The cash loans to cultivators were now given for preliminary cultivation operations like

(3) Report on the Ceylon Co-operative Movement 1957. *By P. E. Weeraman, C. C. D. & R. C. S.*

(4) Administration Report of the Commissioner of Agrarian Services, 1965—69 (Part I Civil KK). *By M. S. Perera — October 1967.*

(5) In the 1940 s paddy was purchased under the Internal Purchase Scheme by the Commodity Purchase Department. Later the agency to purchase paddy under the Guaranteed Price Scheme was vested in the co-operative societies.

tillage, asweddumization of new lands, and construction of ridges in the fields of the newly asweddumized areas. The fertilizer loan was given in cash not exceeding Rs. 250/- per member. All other loans continued to be given in kind. Certain additional items for which cash credit could be obtained were provided. They were the purchase of seed paddy, construction of stores and go-downs and purchase of vehicles for the transportation of paddy. Gradually the number of items for which credit was made available was increased. These loans were given under three schemes; short term, medium term and long term.

The distribution of fertilizers was undertaken by the Agrarian Services Department. The government had introduced a subsidy scheme for fertilizers in 1950. A 33⅓% on credit sales were given to the cultivators. In addition to the government sources of credit the Co-operative Banks also lent to member societies out of their own funds. Many of the Co-operative Banks were absorbed by the Peoples' Bank when it was established in 1961. From this time onwards the Peoples' Bank was drawn into the scheme of the distribution of loans. All these meant an expansion of credit facilities during this phase in an unprecedented manner. At the receiving end of the facilities were the unenterprising and indolent cultivators who were developing a psychosis that it was the responsibility of all (mainly government) but themselves to feed them and look after their welfare. At the policy making level was that apparent urgency to solve the pressing economic problems within the shortest possible time. The implementation machinery was disorderly both at the departmental and at the village organisational level. The many departments—Agrarian Services, Co-operative and Agriculture mainly—the Co-operative Banks and the Peoples' Bank were involved in giving loans. The C.A.P. & S. and M. P. C. Societies and cultivation committees were the village level organisations that were involved in this work.[6] The determination of the specific functions of the respective organs of this machinery was incomplete. Co-ordination was lacking. This fact has been commented upon by the committee on Agricultural credit as follows.[7] "It is nevertheless true

(6) This organisational set-up continues even now.

(7) This is an extract from the report of the Committee appointed in January 1966 to make recommendations on agricultural credit.

that there is some degree of overlapping between these two institutions." The two institutions referred to here are the co-operative society and the cultivation committee. The Commissioner of Co-operative Development further elaborates this situation. Specially at the primary level, glaring instances of lack of co-ordination between the Multi-purpose Co-operative societies, on the one hand and the Rural Development societies, Cultivation committees and the Village Councils on the other are noticed."[8] Certain functions could not be effectively carried out due to weaknesses in the procedure. For example the recovery of loans through the arbitration procedure caused intolerable delays.[9] A sustained supervision and evaluation of the progress was not considered a requirement. Consciously or unconsciously this situation was taken as a necessary phase. The government seemed to have believed in the dictum of "increased credit facilities for increased paddy production." The loans granted from 1947 onwards shown in table 1 implies this. By 30th September 1963 the value of loans so granted amounted to Rs. 192,555,392/-.[10]

In 1963 July, the credit scheme was completely revised and it was called the new expanded agricultural credit scheme. Now a crash programme for the increase of paddy production was introduced. This is the beginning of the third phase. A member cultivator's credit limit was raised to a maximum of Rs. 1700/-.[11] The amount that a member could draw from a society varied from Rs. 175/- per acre per 'Kanna'[12] depending on the number of shares held in the societies and also the actual number of acres cultivated. The maximum number of acres for which credit was allowed was five acres. Within this liberalisation of credit the amount granted to cultivators during 1963/64 shot up to Rs. 34,588,000/- from Rs. 10,667,000/- in 1962/63 — refer to table 2. However along with the liberalization of credit an Act was also was passed

(8) Report on the Ceylon Co-operative movement for 1963—64 pp. D . 80. *By H. S. Wanasinghe (September 1965).*

(9) This situation still prevails.

(10) Report of the committee on Agricultural Credit (January 1966).

(11) This includes the cultivation loan for seasons and the marketing advance.

(12) 'Kanna' in local terminology means the season of cultivation. The two 'Kannas' are Yala and Maha.

TABLE 2.

*LOANS GRANTED, AMOUNTS RECOVERED ANNUALLY AND BALANCE OUTSTANDING AT THE END OF EACH YEAR.

Year	Loans granted Rs.	Recoveries Rs.	Balance outstanding Rs.
1947—48	4,356,000	2,544,000	1,812,000
1948—49	5,563,000	2,040,000	5,335,000
1949—50	4,247,000	3,654,000	5,924,000
1950—51	6,695,000	4,147,000	8,472,000
1951—52	8,836,000	7,420,000	9,888,000
1952—53	15,864,000	7,428,000	18,324,000
1953—54	11,709,000	11,305,000	18,728,000
1954—55	14,674,000	15,030,000	18,372,000
1955—56	18,370,000	17,512,000	19,230,000
1956—57	21,934,000	21,787,000	19,377,000
1957—58	13,809,000	12,544,000	20,642,000
1958—59	18,382,000	13,022,000	26,022,000
1959—60	13,961,000	13,815,000	26,148,000
1960—61	11,406,000	13,395,000	24,159,000
1961—62	12,618,000	13,134,000	23,643,000
1962—63	10,667,000	9,462,000	24,848,000
1963—64	34,588,000	16,200,000	43,200,000
1964—65	27,555,000	16,517,000	54,238,000
1965—66	28,138,000	21,324,000	61,052,000
Total	283,372,000	222,280,000	—

*Extracted from the Administration Report of the Commissioner of Agrarian Services, 1965—66 ; pp. KK39.

in Parliament to strengthen the methods of recovery. If any action to make the recoveries in accordance with this act are taken such instances are extremely rare mainly due to the involved procedure to be followed. During the latter part of this period the government began to lay a greater emphasis on agricultural development in the country than even before. A five year plan entitled "Agricultural Development Proposals 1966—70" was prepared. This plan is broken up into annual plans. The annual plans are again broken up into district plans. In the preparation of district plans the administrative division of a Divisional Revenue Officer is taken as the constituent smaller unit. Right along this line of planning the degree of emphasis placed on paddy production is quite obvious. The elaborateness with which specific targets even for component activities have been fixed is sufficient evidence for this.

In the implementation of the plan several changes have been made. Along with them is the complete revision of the New Expanded Agricultural Credit Scheme. Before the actual revision an investigation was carried out to find out the causes for the defects of the existing credit scheme. Based on the findings and conclusions of the committee[13] appointed to conduct the investigation, the revised credit scheme called "The New Agricultural Credit Scheme" was introduced on 1st September 1967. Now the credit limit of a member cultivator was increased to a maximum of Rs. 4,000/-. The amount that can be borrowed within this limit varies from Rs. 220/- per acre per 'Kanna' depending on the number of shares held in the society and the number of acres cultivated. According to the earlier scheme the credit was given to the cultivator to a maximum extent of five acres; but under the present scheme the limit is raised to the extent of ten acres. Arrangement is made to loan out fertilizers, seed paddy, agricultural implements and insecticides in kind.

This brief survey makes it clear that from the very inception the amount of credit granted per cultivator as well as the total amount from year to year has progressively

(13) This committee was appointed in January 1966. Its report was issued in June 1967.

increased. (Table 2 and Figure 1) No system of credit has operated to the required degree of satisfaction. This is evident from the several revisions made from time to time. Considering the degree of emphasis that has been laid on the credit aspect this whole effort may be more appropriately identified as a credit oriented development in paddy cultivation. Its course is marked by certain parts of activity showing the lack of a definite pre-planned approach — the graph showing the credit granted from 1947 to 1966 makes this clear. It is time now once again to review this programme more realistically. The results achieved so far may be encouraging in some ways; but if the results are assessed against inputs, the necessity to approach the problem more realistically becomes evident. If the credit schemes so far operated had been development oriented by now the cultivators should have been free from debts. The credit obtained by the cultivators should be an investment on paddy cultivation capable of earning more returns; so that with the excess income the cultivators' next credit requirements proportionately decrease. Lapse of a few years would enable the cultivators to be self-supporting at least in those areas which are less subject to unavoidable natural hazards like floods and droughts. But the present plight of the cultivators is one of continued increasing indebtedness both to the government and to private sources. No doubt this is tied with other problems and characteristics of a developing economy or rather a slow moving economy that is challenged by ever renewing situations; but then the adjustment is needed however hard and unpleasant.

The requirements for cash credit for cultivation operations vary in the different parts of the island depending on the extents of cultivable land holdings and the sources of income. In the dry zone areas of Ceylon extent of paddy lands and the individual holdings are large. In many of the colonies individual holdings are more than three acres in extent. Preliminary cultivation operations in such areas involve a considerable amount of labour. The mutual labour on the basis of mutual help is now a vanishing feature in the cultivation operations. Hired labour is fast taking its place especially in the newly colonised areas. Buffaloes are rapidly decreasing in numbers due to lack of suitable pasture and also due to illicit slaughtering. Tractors have already

substituted the wooden plough and the buffaloes. As a recognition of this position the Ministry of Agriculture states "In order to ease the present shortage of agricultural tractors it is proposed to permit the importation of about 1500 four-wheeled tractors and 500 two-wheeled tractors with adequate implements and spares during 1966".[14] Even transplanting, weeding and harvesting require hired labour if the extents are more than one acre. In most of the dry zone areas paddy is the only source of dependable income. Vegetable and other cereals like kurakkan cultivated on chenas do not bring a sufficient income and is not a dependable source. In the colonization areas this possibility is further limited unlike in the traditional village areas. Therefore it is indisputable that cash credit must be made available to the cultivators in such areas. The districts of Anuradhapura, Amparai, Polonnaruwa, Trincomalee, Batticaloa, Mannar, Hambantota, Moneragala, Vavuniya and certain parts of Puttalam district come under this category.[15] Examination of table 3 shows that the largest amounts of credit have been drawn by these areas.

In the hilly areas the problem takes a different form. The districts in the hill country[16] fall into a different category. The districts are Nuwara Eliya, Badulla, Kandy, Matale and some parts of Ratnapura district. In these areas the holdings of paddy lands are small. The rural settlements are mostly of the traditional type. An individual farmer with the help of the other members of the family can cultivate the holdings without hired labour. Even if labour is required such labour is available on the basis of mutual help. As far as land use pattern is concerned high lands are occupied by either small holdings of tea, rubber, cocoa or a mixed cultivation of crops like coffee, pepper, arecanut, cardamom etc. or else a seasonal cultivation of vegetables. A typical area where this pattern is noticeable is Badulla district; "the district is one of the main suppliers of vegetables. During the Yala

(14) Implementation Programme and Targets 1966. (Paddy and Subsidiary Food Stuffs) pp. 4. Ministry of Agriculture and Food.

(15) Other colonization schemes in the dry zone not belonging to the districts already named must be considered under this category.

(16) The area over 1000 ft elevation is taken as to define the hill country here.

TABLE 3.

*DISTRICT — WISE CLASSIFICATION OF LOANS.

District.	Loans granted in 1964–65. Rs. cts.	Loans granted in 1965–66. Rs. cts.
Anuradhapura	3,568,489.55	6,580,273.61
Badulla/Moneragala	590,085.76	460,930.00
	1,234,983.18	948,904.00
Batticaloa/Amparai	2,102,087.48	2,498,424.75
	893,699.43	496,445.14
Colombo	400,618.54	87,072.25
Galle	883,664.61	483,147.50
Hambantota	2,120,203.98	2,971,517.00
Jaffna	2,572,655.50	2,478,323.80
Kandy	1,815,747.29	821,585.00
Kalutara	393,576.44	171,983.00
Kegalle	155,117.73	94,126.00
Kurunegala	820,759.30	1,344,588.02
Matale	473,283.44	289,795.00
Matara	415,521.89	376,352.00
Mannar	1,212,940.46	1,371,400.50
Nuwara Eliya	207,692.24	236,856.45
Polonnaruwa	3,763,807.56	3,326,890.80
Puttalam	512,023.25	665,467.00
Ratnapura	493,895.47	429,232.00
Trincomalee	845,600.30	1,115,673.13
Vavuniya	2,079,375.40	889,027.58
TOTAL:	27,555,828.80	28,138,014.53

* Extracted from the Administration Report of the Commissioner of Agrarian Services 1965—66; pp. KK 41.

season much of this is cultivated on paddy fields."[17]. The high-lands unlike in the dry zone areas, are therefore more productive and provide an alternative source of income. Ploughing with the wooden plough and buffaloes or as is practised in many areas turning the earth over with the mammoty are the techniques that are usually employed in preparing the fields before sowing or transplanting. Therefore the question of tractors being hired does not arise. Cash credit is not an acute problem in such areas. Moreover in the areas covering this category many holdings of paddy lands are less than $\frac{1}{2}$ an acre. Although the cultivators do not work out the economics in cultivation, by experience or intuitively they know that it is uneconomic to work such small extents after investing borrowed capital. After a review of the progress in the application for loans by the cultivators the Government Agent for Kandy District has drawn attention[18] to the fact that cultivators working holdings less than $\frac{1}{2}$ an acre in extent have not applied for loans under the new credit scheme. As it is the cash loans that are given to cultivators in these areas are mostly spent on subsistence needs. Although it is supposed to be an investment on paddy cultivation in fact it becomes consumption credit promoting the habits of wasteful expenditure among the cultivators in such areas.

The peasantry in the coconut belt of the island fall into yet another category. The small holdings of coconut assure a regular income. The individual field extents are large; but the holdings per individual are less than two acres on an average. This is an intermediate type in between the dry zone areas and the hilly areas. For ploughing tractors are employed to a certain extent. But unlike in the previously described areas, here still the wooden plough is used, partly because buffaloes are more easily reared as the coconut lands provide sufficient pasture to feed them. However with the sub-division of land holdings the problem of scarcity of pasture is being felt gradually. The cultivators are not wholly dependent on an outside source of credit

(17) Badulla District Agricultural Programme Maha 1967/68—District Agricultural Committee, Badulla. pp—2.

(18) 1966 — 70 Agricultural Development Proposals: **Implementation Programme** (1968) Kandy District.

for preliminary cultivation operations. Hired labour is restricted to situations where mutual help is not obtainable. Labour costs are not accrued by the cultivators to the same extent as in the colonization areas. Transplanting and weeding are not practised throughout the area especially when the holdings are larger than the two acres. Cash credit therefore cannot be considered a critical factor in the increased paddy production in this area. Almost liberally provided credit is mostly spent on purposes other than paddy production. The districts under this group are Kurunegala, (south of Deduru Oya), Chilaw—Puttalam, Colombo, Kalutara, Galle and Matara.

The entire Jaffna peninsula is an area by itself. There are no perennial crops supplementing the income from paddy. It is the income earned from paddy cultivation and other short-term crops that is available to the cultivators to spend on day to day consumption and investment on the cultivation operations of the following seasons. The expenses of labour though not high are incurred to make them dependent on some foreign source of credit.

Hence a scheme of regulated cash credit to meet the more realistic demands of the different areas is needed. A careful assessment of the actual requirements in the various areas is therefore a pre-requisite to such a scheme.

The fertilizer loan is given in kind. $33\frac{1}{3}\%$ of the cost of the fertilizers is subsidised by the government. It is hardly necessary to over-emphasise the need for application of artificial fertilizers in the paddy lands of Ceylon today. The continued cultivation over a period of years has depleted the soil of its natural fertility. This is not the time in Ceylon to let natural fertility alone determine the crop yields. The objective for maximization of yields has to be achieved under more and more scientifically controlled conditions which produce the best results. The fertilizer loan with a subsidy therefore is a very important item in the credit scheme.

Similarly to yield targets, fertilizer targets also have been set in the implementation programmes. Attempts at persuasion of the cultivators to use more fertilizers according to the correct formula have met with slow responses.

The reasons for this pace cannot be attributed to the ignorance of the cultivators. The availability of water is the ultimate factor that determines the application of fertilizers. Where irrigation facilities are provided at public expenditure the persuasion of the cultivators even to the point of compulsion in the use of fertilizers appears to be justified. In the areas which are wholly dependent on rainfall a more realistic approach seems necessary. Even if 100% subsidy is given, yet it becomes hard to persuade the cultivators to use fertilizers if the cultivations are going to be a failure due to insufficiency of water or droughts. The variability of rainfall in respect of the season of occurrence and the total amount, cause water deficiencies either at one or more stages of the growth of the paddy plant.

Situations of this nature do not warrant the application of fertilizers at the correct stages in required proportions. All areas in the dry zone other than the irrigated areas, and the transitional zone between the wetter south western parts of the island and the dry zone share this risk. Table 4 showing the asweddumized areas according to sources of irrigation reveals this position further. The rainfed acreage is the highest. Many of the minor irrigation schemes are not functioning. Hence the actual extent cultivated is less. Under this set up participation of the cultivators in the

TABLE 4.

*ASWEDDUMIZED AREAS ACCORDING TO SOURCES OF IRRIGATION. (in acres)

	Total Extent.	Extent sown for Maha 1965/66.
I. Major irrigation schemes	402,350	314,732
II. Minor irrigation schemes	388,345	283,798
III. Rainfall area	533,160	451,536
TOTAL:	1,323,855	1,050,066

* Extracted from the "Administrative Report of the Commissioner of Agrarian Servics, 1965—66; pp. — KK60.

fertilizer programme is slow and hesitant. It is only through the Co-operative societies that the cultivators can obtain the fertilizer loans. For a member cultivator to be eligible for a fertilizer loan his shares and loan payments to the society should not have fallen into arrears. Invariably a good percentage of the cultivator members are either defaulters in share payments or loan repayments. It is relevant to reiterate the observation made in a survey conducted jointly by the Department of Agrarian Services and the Department of Census and Statistics in 1962. At the time only 65% of paddy cultivators had become members of any co-operative society. About half of them were ineligible for loans being share defaulters. About one third the number of credit societies were not credit worthy.(19) It is due to lack of funds that the cultivators are given fertilizer loans, but here is a situation where many cultivators are not eligible even for the loan. All the propaganda made and the administrative devices set up to achieve fixed targets face a challenge in such circumstances. The emphasis on two season cultivation where rainfall reliability is less is again over-enthusiasm divorced of reality. In areas where cultivation is wholly rainfed the cultivators are experienced in determining the more reliable seasons of cultivation. The cultivators in Ceylon are normally reluctant to take risks mainly because of economic insecurity. Winning the confidence of the cultivators therefore is a pre-requisite to the implementation of the programmes. The literacy of the cultivators is not so high as to follow a little too confused and detailed formula of fertilizer application currently prevailing unless there is consistent guidance and direction. As a result according to the Agrarian Services Commissioner "Another notable feature in the present trend of consumption of fertilizer is the use of nitrogen without the application of the correct ammounts of potassium and phosphate fertilizers".(20) To overcome this problem so far no effective measures have been taken, but "this matter is

(19) Report of the committee on Agricultural credit issued in June 1967, There is only a little change now in the position The decision of the government to waive off outstanding overdue loans of the period prior to 1958 and granting extensions to the repayment of loans of the subsequent period has increased the number of credit worthy cultivator members. But it has to be seen how long this system can be continued.

engaging the attention of the Department of Agriculture and there is a proposal to recommend mixed fertilizers," (21). The required amount of fertilizers is not applied in the fields in many instances due to this reason too. The problem of unavailability of fertilizers in time and lack of facilities for storage are not so insurmountable as is evidenced from the achievement of targets set for the construction of stores and the supply of required quantities at the correct time.

The provision is made to grant seed paddy loans in kind. For this there must be a sufficient quantity of tested and guaranteed seed paddy. As it is, paddy is bred at one central rice breeding centre—Batalagoda and distributed to registered seed farms managed by government in different provinces. From these farms the seed paddy is again distributed to selected registered farmers in the villages, who in turn multiply it. The paddy multiplied after testing is bought by the Agriculture Department to be distributed to cultivators under the credit scheme. The experience in the past is that there has never been a sufficient quantity of seed paddy to be distributed to the cultivators. Even the seed distributed on several occassions have not germinated after sowing. In a programme where cultivatior participation actively and voluntarily is the basis, set-backs of this nature can be demoralising. Insufficiency of precautions taken in the handling and storage of paddy has led to the deterioration of the quality of seed. There is no assurance that seed produced in one locality will be distributed to the cultivators in the same area. Very often it may happen that seed produced in the Amparai district is distributed among cultivators in the Kandy district. This leads to greater chances of seed paddy not being distributed on time.

Agricultural implements including tractors are in short supply. Most of these are imported from abroad. The unfavourable position in foreign exchange resulted in the restriction of the supply during the past few years. Now since some of the implements like mamoties are being turned out in the country itself there is a general improvement of the supply. The local production however has not kept pace with the demand. The replacement of the traditional

(20) & (21) Administration Report of the Commissioner of Agrarian Ser ices 1965-66; pp—KK 49.

form of ploughing by tractor ploughing will make the necessity for cash credit felt more and more in time to come. When more credit facilities are available for tractor ploughing, even where available the traditional form of ploughing may be wilfully abandoned by the cultivators. This can lead to several problems. More tractors will have to be imported and it then becomes a compulsory item in foreign exchange allocations. The agricultural sector would be left with a greater number of unemployed persons. In the rural sector there are no indications of any other economic activities to absorb the excess labour. The production costs of paddy tend to rise making the cultivation operations uneconomic to the small holders. The diseases and insect pests the paddy plant is subject to are numerous. They vary from area to area and season to season. Although insecticides, weedicides and other chemical applications are made available it is the treatment of the plants at the critical time that can save a crop from damage. This requires a competency to comprehend the diseases and insect infestations. It is still too premature to leave this task entirely to the cultivators in the villages. Evidence is considerable that in spite of advanced research, extension services, credit facilities and elaborate distribution devices the paddy crops have been destroyed by diseases and insect infestations unknown to the village cultivators. On occasions of this type the cultivators have attributed the loss to various causes including the use of artificial fertilizers. The repercussions of breeding a suspicious environment of this nature in the cultivator population can cause irreparable damage. Perhaps a district-wise centralised service with expert knowledge and experience to attend to this aspect of paddy cultivation is a possible solution to the problem.

The credit scheme is only a means to achieve a certain objective. In breaking down the paddy production programme to its components of implementation, targets have been set for expected yields, fertilizers, seed paddy and amount of cash credit. Unfortunately the tendency is for the achievement of targets in specific items in isolation, without relating them to ultimate yields. In the distribution of cash credit this attitude has been in evidence resulting in a wastage of resources. Seed paddy and fertilizers are similarly wasted.

The credit given must be effectively supervised to ensure that it becomes an investment on paddy cultivation alone. At present all attempts are made to perfect the distribution of credit both in cash and kind. All credit reaches the cultivators through Co-operative societies. The Co-operative credit is supposed to be supervised credit. This according to the present scheme is rather a presumption in principle. This is evident fron the admission of the field officers in charge of the supervision of these societies in the districts recorded as follows: "The unanimous opinion of the conference was that it will not be possible for this Department to supervise the proper utilization of loans under the credit scheme. It would be advisable to keep the Ministry[22] informed of this position."[23] The degree of supervision exercised by the Co-operative societies is hardly adequate to ensure the functioning of a satisfactory credit-oriented development in paddy cultivation. This is one of the reasons that has been contributory to the increased indebtedness of the cultivators.

The recovery of loans has neither been so easy nor so difficult. In the clarification of this paradoxical situation it is once again necessary to quote from the Report of the Committee on Agricultural credit issued in June 1967. "From 1947 and up to 30th September, 1963, the total volume of loans granted on this basis amounted to Rs. 192,555,392/-. The total recoveries up to that date was Rs. 167,707,208/-. The balance outstanding was Rs. 24,848,184/- or 12.9 per cent of all loans granted since 1947. Of this amount, the amount in default was Rs. 18,219,730/- or approximately 9.4 per cent". From 1963/64 onwards the recovery position has been progressively improving according to the statistics supplied by the Commissioner of Agrarian Services; see Fig. 1. The 'ups' are above mentioned spurts of credit actively associated with new schemes and their modifications. The 'downs' are a result of subsequent ineligibility for loans due to defaulting. The recoveries have always fallen short of the amounts

(22) Here the Ministry means the Ministry of Food and Agriculture. The credit scheme functions under the Ministry.

(23) Extract from the minutes of an all island conference of staff officers of the Co-operative Development held on the 9th and 10th August 1967.

TABLE 5.

*RECOVERY ON LOANS SINCE THE OPERATION OF THE NEW CREDIT SCHEME IN 1963—64.

Year	Recoveries as a percentage on loans granted during the year.
1963 — 64	46.8%
1964 — 65	59.9%
1965 — 66	75.8%

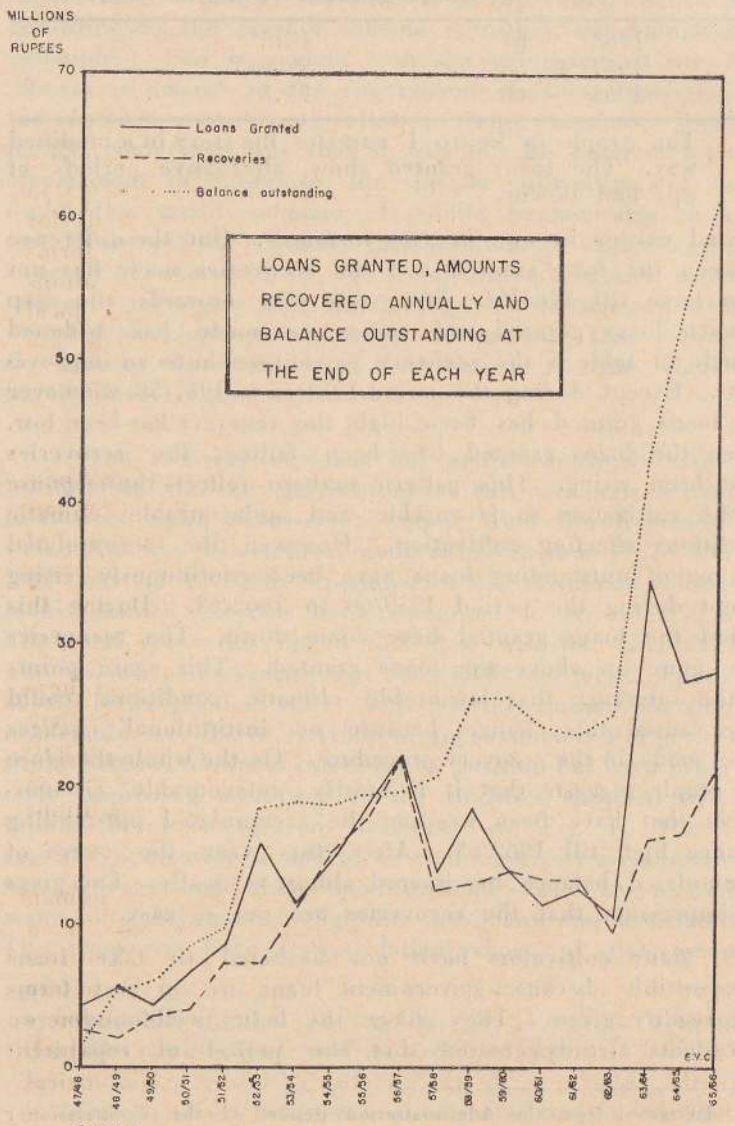
The graph in figure 1 narrates the story in a modified way. The loans granted show, alternative periods of ups and downs.

granted except in one or two instances. But the difference between the loan granted and the recoveries made has not been large till 1963/64. From this year onwards the gap between loans granted and recoveries made has widened though in table 5 the recovery percentage shows an improvement. Except during the period 1954/55 to 1957/58, whenever the loans granted has been high the recovery has been low. When the loans granted had been falling, the recoveries have been rising. This pattern perhaps reflects the response of the cultivators to favourable and unfavourable climatic conditions affecting cultivation. However the accumulated balance of outstanding loans have been continuously rising except during the period 1959/60 to 1962/63. During this period the loans granted have come down. The recoveries have gone up above the loans granted. This again points to the inference that favourable climatic conditions could have caused this change; because no institutional changes were made in the recovery procedure. On the whole therefore the graph suggests that it is mostly unfavourable circumstances that have been keeping the accumulated outstanding balance high till 1962/63. After this year the curve of accumulated balance has soared almost vertically. This gives an impression that the recoveries are not so easy.

Many cultivators have not hesitated to take loans irresponsibly because government loans are on easy terms and readily given. They have the belief well-founded on precedents already created that the period of repayment

* Extracted from the Administration Report of the Commissioner of Agrarian Services 1965—66. pp. KK39.

would be extended or else the entire loan will be written off. In view of this situation it would become an interesting exercise to calculate the cost / benefit ratios in the production of a bushel of paddy, from the very inception of the credit schemes in Ceylon.



Source: The Administration report of the Commissioner of Agrarian Services 1965-66

FIG. 1

STRATEGY FOR AGRICULTURAL DEVELOPMENT

RAINER SCHICKELE

MODERN technology throughout the developing countries is beginning to revolutionize agricultural production processes. High-yielding crop varieties, new methods for controlling weeds, insects and diseases, more efficient forms and combinations of plant nutrients and fertilizer applications and farm machinery adapted to different crops and local conditions of soil, climate, topography and farm sizes are being developed.

ACCELERATING ADOPTION OF TECHNOLOGY

In fact, the rate of progress in developing these new production techniques has been amazingly fast in the last fifteen or twenty years, very much faster than the rate of their adoption by farmers. Only a small proportion of farmers is using them efficiently and in combinations adapted to their local conditions. Why should these be so?

It is much easier and faster to discover each of these new techniques in laboratories and experimental fields than to find out which ones and in what combinations and proportions they are most suitable to any particular local set of ecological, economic and social conditions. These conditions vary widely in different countries and areas.

Some of these conditions can be changed by human effort to fit the requirements of modern technology, such as relationships between prices of crops and costs of fertilizer and other inputs, access to credit needed by farmers to buy the modern inputs, tenure conditions encouraging farmers to adopt modern techniques, and extension services which guide and assist farmers in practising these technological innovations. Other conditions cannot be changed, such as soil types and climates, and still others can be changed only

with high costs, such as impounding water and building far-flung irrigation systems or transforming steep hillsides into local terraces.

These examples reveal two strategic requirements for agricultural development which must be met before most farmers really are in a position to modernize their productive processes. The first requirement is to find out the kinds of imputs and their combinations best adapted to those local conditions which cannot be changed, particularly to soil types, climate and topography. The second requirement is to change local conditions amenable to human control, particularly certain economic and social conditions obstructing farmers in applying scientific production methods.

I shall deal mainly with this second strategic problem: how to overcome the economic and social obstacles to agricultural progress.

CAPITAL NEEDS FOR MODERN INPUTS

Large amounts of operating capital have to be made available in the form of fertilizer, improved seeds, pesticides, farm machinery and equipment. Without these modern inputs, farmers cannot increase production significantly. Hence, agricultural development programs must provide for ready availability of these modern inputs at attractive prices and terms. Recent studies have shown that under traditional farming methods without the modern inputs, the peasants are often remarkably efficient and could not do much better than they are doing.

ADAPTING TECHNIQUES TO LOCAL CONDITIONS

As these modern inputs become available, the government must guide their introduction into the production process through various types of programs, such as local verification research through trials and demonstrations on cultivators' fields for testing the suitability of specific fertilizers, better seed and pesticides to local conditions. Many of these inputs can be as effective on small as on large farms. Tractors and other farm equipment which cannot pay for themselves on a single small farm can be used jointly by a group of farmers through co-operatives, or through private machinery operators doing custom-work on farms for hire, or through government tractor stations.

Little of this is done in Ceylon in a systematic way for various crops and livestock enterprises. This may be one of the reasons why crop diversification especially for such subsidiary crops as chillies, pulses and onions, make such a slow headway. We know how to produce them in the Jaffna District; but the same methods do not seem to fit conditions in the central and southern Dry Zone nearly as well.

There is no effective program for testing which kinds of tractors (including two-wheel models) and their attachments, and threshing, winnowing and sorting machinery are most suitable for various crops in different areas. Without such tests we cannot hope to catch up with the farmers in Japan and Taiwan in productive efficiency because we do not know what we can confidently advise farmers to do in these respects.

Where Ceylon has done considerable work is in testing the adaptability of improved paddy varieties. This was done not only with varieties developed here, but with some from abroad as well, including the new high-yielding varieties from the International Rice Research Institute in the Philippines, such as IR-8. Also, local verification trials of fertilizer on cultivators' fields have been in operation for a number of years under the Ceylon Fertilizer Project sponsored jointly by the Government of Ceylon and the FAO of the United Nations.

With the use of fertilizer for paddy production we have made some progress—but much too slowly. Fertilizer consumption has increased from 3,000 tons in 1952/53 to around 85,000 tons in 1966/67. This amounts to a dose of less than 1 cwt. per acre on the average for the total paddy acreage sown of 1.6 mil. Why have we not done better over this 15 year period? Mainly because of lack of credit, availability of sufficient supplies of the proper kind at the right time, and lack of effective extension service at the farm level. A rough estimate indicates that to become self-sufficient in paddy production, fertilizer consumption would have to reach an order of magnitude of 400,000 tons,

an amount five-fold over 1966/67. This would provide for a dose of 5 cwt. per acre of paddy which, along with much improved weed and pest control and high-yielding varieties will probably be required to reach the goal.

EXTENSION SERVICE:
LINK BETWEEN SCIENTIST AND FARMER.

Equally important is it to train a large number of extension workers and administrative officers for co-operative and government services to agriculture. Lack of trained personnel retards progress on small farms as much as on large-scale farms. For both types of farming, there is special need for many field level workers trained in simple but locally important skills. An effective linkage between the highly trained experts and the farmers must be provided.

The introduction of modern production methods requires technicians. While in industry such a group of technicians can be assigned to one large factory employing hundreds and even thousands of workers, in agriculture it must be assigned to work with a few hundreds of individual farmers, and with farmers' co-operatives and government services, and with agricultural workers on large-scale private or state farms. We must recognize that due to the spatial dispersion and to the limited scope for routinization of the agricultural production process, a considerably smaller number of workers in the agricultural labour force can be served by such a group of technicians than in industry. This holds for large-scale as well as for family-scale farming—which is too easily overlooked in the planning and operation of large-scale farms.

In Ceylon, there are about 1.2 million farmers operating holdings of less than 50 acres in size. Experience in other Asian countries suggests that an extension village level worker loses rapidly his impact if he is asked to serve an area with more than 250—300 farmers. To avoid such dissipation of effort would require 4,800 extension workers at the village level, or an average of about 1.3 per Cultivation Committee. In 1965, there were only 410 extension workers ("Agricultural Instructors") at the field level, less than one-tenth of what is needed.(1) They should have at least a one-year vocational Farm School training at the beginning, with subsequent in-service training and short-courses annually; as soon as possible, a 2-year course certificate from a School of Agriculture should be required for these posts.

These farm level workers need the technical support and supervision of more highly trained officers with some technical specialization. If one of these district officers were to guide 20 field workers, 250 district officers with at least a 4 year-course University degree would be required. In 1965 only 25 district extension officers were provided, again one-tenth of what is needed.

These shortages of extension personnel, and of the training facilities required to produce them, create severe obstacles to the acceleration of agricultural production increases. What makes the situation worse is that the crucial function of this cadre of village and district level extension officers does not seem to be fully recognized in leading government circles since so far there has not been the demand for them expressed in a systematic expansion of posts at salaries which will attract competent persons and keep them growing in their jobs.

LOCALIZING AGRICULTURAL PROGRAMS — GIVING EXTENSION SERVICE ROOTS AND A FOCUS

Planners and high government officials may well know what kind of agricultural programs the country needs to get off the ground. For instance, they may agree that a land reform and a credit program are necessary to offer farmers incentives for increasing production and access to modern inputs. These policies are conceived in terms of national programs, of nation-wide implementation, and their administrative and financial provisions are based on national operational requirements.

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(1) E. C. de Silva, Agricultural Education in the Economic Development of Ceylon. Journal of the National Agricultural Society of Ceylon, Vol. 3, No. 1, June 1966, p. 9.

This conception of agricultural policies is theoretically sound, but practically often unrealistic and misleading, and is resulting in much waste of scarce trained manpower and financial resources. The reason : agriculture is so dispersed, production is in the hands of so many small farmers, and farming methods vary so much with local conditions that a nation-wide agricultural program requires a staff of technical officers much larger than most countries, and particularly Ceylon, have at their disposal at the present time. Since it is often physically impossible to implement a national agricultural program effectively everywhere at the same time, it is much wiser to select certain strategically located areas, concentrate the trained personnel in these areas and implement the program there efficiently, rather than dissipate the scarce personnel over so large an area that their efforts leave no impact.

This basic principle was adopted recently, although only on a small scale, as a pilot scheme that might be expanded as experience is gained. The government has designated a number of areas as "Special Project Areas", in which the field staff was strengthened and the various government departments' functions coordinated on the local level by a Chief Project Officer or Project Manager. The beneficial result of such concentration and coordination of effort was revealed by a socio-economic Survey of the Elahera Colonization Project undertaken by the University of Ceylon in collaboration with the Ministry's Department of Agriculture during the Maha 1967/68 season. In the summer of 1968, the Government decided to establish 8 more similar "Special Project Areas" for Maha 1968/69.

There are many ways in which this principle can be applied. For instance: formulate a realistic project which fits the area selected, assign two good officers to it, complement them with junior and apprentice staff to assist the officers and at the same time receive on-the-job training from them. After two years, when the project gets well underway, leave one of the senior officers with some field workers to carry on, and move the rest of the team to another area with additional junior and apprentice staff assigned to it. Set up additional teams with newly trained officers to cover more and more areas. The impact of this

procedure over a 10 year period will be much greater than if the same extension personnel had been distributed evenly over all farms.

It will become more and more difficult to staff these rapidly expanding spear-head areas of development with competent and energetic officers, unless the training facilities are expanded accordingly, and attractive salaries and employment terms are offered. There is no doubt that the public investment in such a cadre of well trained and well supported extension workers will yield high returns to agriculture and the nation.

COMPLEMENTARY MEASURES

I have emphasized the need for a greatly expanded and re-oriented extension service because in many developing countries (including Ceylon) it is a very weak link in the chain of events leading to vigorous agricultural growth. This neglect may well stem from the fact that the bridge between technology and practical production processes in industry is provided largely by industrial management in the private sector itself, while in agriculture it must be provided by government services. More-over, to the urban-oriented mind, agriculture is often still conceived as a "set of inherited motions" by peasants incapable of using scientific production methods and performing modern entrepreneurial functions. This conception is patently wrong: where-ever in the world a good extension service has been established and complementary measures have been taken to make it profitable, farmers have proven their capacity to become highly skilled in the practice of technology and efficient as modern entrepreneurs.

It is true that even the best extension service could not function well without several complementary measures required to remove obstacles which prevent farmers from modernising techniques and farm management methods.

The kinds and severity of these obstacles vary greatly between countries. In many Latin-American countries, tremendous concentration of ownership in the hands of few absentee landlords has led to a tenure system which deprives farmers of opportunities for progress. Here, land

reform measures rank high in the strategy of development. In some African countries, elementary education is still so new and illiteracy so common, that schools, roads, and teacher training have a very high priority. In many Asian countries, agricultural credit, marketing and processing facilities for farm products are so inadequate that substantial investments in these fields are essential. Even within a given country, such differences in the nature of obstacles often exist between various areas.

In Ceylon, perhaps one of the key measures required for progress in large parts of the Dry Zone is improvement of marketing, processing and transport facilities. In many old agricultural areas in the Wet Zone, certain land reform measures concerning rent control, and agricultural credit measures concerning the linkage of crop marketing and credit management through efficient multiple-purpose cooperative societies appear to be of high strategic importance.

Ceylon has been quite imaginative in tackling some of these obstacles to progress. The Guaranteed Price Support Program has given paddy farmers a strong incentive for increasing production; coupled with a subsidy on fertilizer cost, increasing paddy yields by liberal application of fertilizer has been very profitable for a number of years. The reason why the great majority of farmers have not taken advantage of this favourable price-cost relation can be found in the weak link between scientist and farmers (that is extension service at the farm level), the lack of availability of fertilizer in the villages at the time they are needed, and the inadequacy of credit arrangements which made access to credit much too cumbersome and slow to meet farmers' needs.

In the fall of 1967, an attempt was made to overcome these obstacles in a planned and systematic way. The credit program was streamlined by assigning to the multipurpose cooperatives the task of managing it. This decentralization cuts out a lot of red tape and delay, from the time the farmer applies for a loan to the time he gets the money, and even to the time the loan is repaid. We have already mentioned that the field staff was strengthened in a number of selected areas, with impressive responses from farmers in the rate of adopting new techniques.

DEFEATING THE "LAW OF DIMINISHING RETURNS"

To understand the basic issues involved in planning a strategy for agricultural development, it is useful to think in terms of patterns or systems of productive factors rather than in terms of single factor contribution to output. A conventional approach in scientific method is to vary one factor and hold all others constant. This tells us the increase in the output attributable to this single factor; as we increase this factor the increments in output diminish because other factors become "limiting factors" insufficient to maintain the previous rates of increase.

In the context of developing agriculture as a whole sector of the economy, the problem is **not** to determine what each factor contributes to the total, but what combinations of various factors and in what proportions to each other do yield the highest output. In the field of technology, this "systems analysis" has enabled us to defeat the law of diminishing returns over wide ranges of factor application; ultimately, of course, certain uncontrollable factors become severely limiting, as climate or moisture supply in agriculture for instance — otherwise we could feed the whole burgeoning world population on one acre of land. The point is that for centuries to come, technology promises to dispel the fear of an absolute ceiling for the world's food supply.

This puts the onus on the social sciences, on planners and administrators, on the organisations and institutions of people. It is now their task to keep pace with science and technology in combining the various human factors, the incentives and motivations of individuals and groups, their organizations and institutions, their public and private services, their land reform and extension programs, their agricultural credit and marketing systems, their Cooperatives and Cultivation Committees — to combine these socio-economic and administrative factors in such proportions as will release the latent human energies to serve the welfare of the people.

We must develop systems of institutions and policy measures which enable individuals and groups and nations to make full use of technology and the productive resources of the world, for the purpose of abolishing hunger and poverty.

FARM PLANNING IN CEYLON: AN APPLICATION OF THE LINEAR PROGRAMMING TECHNIQUE.

T. JOGARATNAM

INTRODUCTION.

THE technique of farm planning is recognised as a valuable tool in helping farmers increase production and raise their levels of income. It has found increasing application in the less developed countries of Asia and Africa and, forms the core of the Intensive Agricultural District Programme in India. Farm planning is bound to receive much greater attention in Ceylon too, once the emphasis in agricultural development shifts from the technical aspects of production to problems of economic resource use and optimum product combinations.

Farm planning is the process by which the resources at the command of the farmer are organised to achieve the desired goal, which is assumed to be maximum profit. Increases in farm productivity can be brought about by the introduction of new practices and new resources. It can also be achieved by a more efficent use of land and labour already available to the farmer as well as by improved combinations of enterprises. The adoption of modern farm practices and the introduction of new farming systems must also be related to the needs, capabilities and interests of the individual farmer. It is in bringing about these adjustments that the technique of farm planning proves invaluable.

Two methods widely employed to plan out the use of resources on a farm are budgeting and linear programming. The objectives, assumptions and requirements are more or less the same for both approaches (2). Both techniques seek to plan out the use of resources available to the farmer with a view to increasing profits. Certain assumptions are required in the application of these tools and the basic

assumption is that of a linear relationship between inputs and output. It is also assumed that there are finite number of alternatives or processes and that the processes are additive and there is no interaction between any two processes. The resources are also assumed to be divisible.

The farms are assumed to operate under a static framework with the institutional set up and technology given. This may be considered a serious disadvantage in a developing country where production conditions are everchanging. However, methods which can handle the dynamic aspects of farm production are available and changes can be incorporated into the planning models if such changes can be foreseen.

Data requirements are also the same for these two methods of farm planning. The basic data that is required relates to the physical quantities of each resource that will be needed and the output of each produce that is expected to result from the use of these resources. The physical data must then be transformed into monetary terms on the basis of expected costs and prices per unit of input and output. It is obvious that the usefulness of the plans will depend largely on the nature of the information that is available. In peasant farming however, the data problem need not prove insurmountable if acceptable information is available relating to labour, yields and prices.

While the objectives, assumptions and data requirements are more or less the same for budgeting and linear programming, the computational procedures are different. Budgeting is non-mathematical and is essentially a trial and error method. A number of alternative plans are decided upon, physical input-output data assembled and appropriate costs and prices applied, the resulting net incomes compared and the budget promising the higest net income selected. Since a large number of alternatives are possible and it is a laborious process to construct budgets for each and every alternative, much depends on the ability to pick on a few alternatives that are most promising. Budgeting cannot therefore guarantee an optimal solution, that is, the one unique plan amongst many that gives the maximum profit. Linear programming, on the other hand, is a refined mathematical tool of analysis that guarantees and optimal solution. It can handle complex problems involving a large number of

alternatives and a host of limiting conditions, though complex problems may require computer facilities. An added advantage in linear programming results from its computational "by-products". The marginal value productivities of the limitational resources as well as the activities not in the plan are also automatically given. These throw light on the rents, wages and interest rates that the farmer could afford to pay as well as on the competitive nature of the different enterprises (5). In general, budgeting is to be preferred where the alternatives are few and the choice simple, while linear programming is to be used where the problems are many and complex.

Both budgeting and linear programming are widely used in the more advanced countries to advice farmers. But given the large number of farmers and the limited resources devoted to extension work in the less developed countries, such an approach is virtually impossible. The only alternative is to adopt the group or mass approach (1). This involves the selection of typical farms representative of farming types in selected areas and preparing farm plans calculated to improve incomes. Such plans could provide valuable guidance to policy makers and also indicate the general lines along which agricultural development should procede. The optimum plans for representative areas could also be adopted to suit the individual requirements of farmers.

FARM PLANNING IN CEYLON.

Farm planning has found little application in Ceylon. Two recent studies present budgets for typical farms situation in the Dry Zone (4, 7). But no attempts have been made to apply the technique of linear programming. An attempt is therefore made here to prepare optimal plans using the linear programming approach.

A typical holding in one of the Dry Zone colonization schemes consisting of 3 acres irrigable lowland and 2 acres highland is taken up for study. It is assumed that the family labour available consists of two full time and two part time workers. This is in line with the findings of the recent Elahera survey (6). Rather than use the total family labour available as one of the restrictive resources, January — February labour and July — August labour are considered restrictive. Capital availabilities are assumed to equal Rs. 2000/-. This again is not considered too high because of the availability of co-operative credit. The availability of labour and capital are varied in subsequent plans to find out the effect on net incomes.

In preparing a feasible cropping programme the variations in soil conditions must be taken into account. Dry zone soils are broadly grouped into Reddish Brown Earths, Low-Humic gley soils and Alluvial soils (4). The Low Humic-gley and Alluvial are generally found in depressions and are considered suitable for paddy only in both Maha and Yala seasons. The Reddish Brown Earths occupy most of the highland areas and are considered suitable for subsidiary crops such as Onions and Chillies. Imperfectly drained Reddish Brown Earths are given over to paddy in the Maha season but can support other crops in the Yala. The availability of water is of crucial importance in the Dry Zone and it is assumed that the lowland is irrigable. Highland allotments are unirrigable at present, but for the purpose of this exercise it is assumed that lift irrigation in Yala is possible.

The basic data for programming are set out in Table 1 and 2. Table 1 lists the resources available for production while Table 2 gives the resource requirements and need income for crops considered feasible.

TABLE 1. RESOURCE AVAILABILITIES.

Low Land	3 acres
High land	2 acres
Human Labour	900 man days
January — February Labour	75 man days
July — August Labour	75 man days
Capital	Rs. 2000.00

TABLE 2. INPUT — OUTPUT DATA*

Item	Paddy	Maize	Potato	Groundnut	Chillies	Onions
Yield per acre	70 bush:	20 cwt.	60 cwt.	12 cwt.	8 cwt.	90 cwt.
Price per unit (Rs)	14	19	80	50	225	28
Gross value (Rs)	980	380	4800	600	1800	2520
Direct costs[1] (Rs)	180	100	1200	225	800	1200
Gross surplus[2] (Rs)	800	280	3600	375	1000	1320
Man days per acre	60	55	100	90	200	150

1. Expenditure on seed, fertilizer, pesticides, tractor hire and irrigation costs
2. Return for family labour, land and livestock investment

* Data based on 3, 4, 6, 7.

Using the above information, the simplex method was adopted to derive the optimum plan. The details of the computational procedure is not presented here and only the results obtained from the final iteration of the programming are given. The optimum plan was worked out for each season separately taking into account the feasible cropping programme. Paddy, maize, potato and groundnut were conridered feasible for the maha, and paddy, groundnut onions and chillies for the yala.

To take into account the variability in physical conditions and resource availabilities, alternative programmes were worked out for different farm situations. The first plan assumed that soil conditions do not permit crops other than paddy in the irrigable lowland while the highland was assumed to be irrigable in the yala. Labour and capital availabilities was fixed, as indicated earlier, at 75 man days each for January — February and July — August, a period of 30 days each, and Rs. 1000/- each for Maha and Yala. Given these assumptions, the following cropping pattern proves optimal.

	Paddy	Potato	Chillies	Net Income
Maha	3	0.4	—	Rs. 3840.00
Yala	3	—	0.4	Rs. 2800.00
				Rs. 6640.00

The above programme produces a net income of Rs. 6640/- and fully utilises the available family labour in the restrictive months. 1.6 acres of highland in each season are not utilised.

An alternative programme using the same resources as above but leaving out the potato crop produced the following optimal cropping pattern:

	Paddy	Maize	Chillies	Net Income
Maha	3	0.75	—	Rs. 2610.00
Yala	3	—	0.4	Rs. 2800 00
				Rs. 5410.00

This programme achieves a net income of Rs. 5410/- but leaves unutilized 1.2 acres and 1.6 acres of the highland in Maha and Yala respectively.

Alternative plans were also worked out with higher levels of labour and capital. If labour is increased to 125 man days for each of the limiting months and capital is increased to Rs. 1500/- each for Maha and Yala, the following plan proves optimal:

	Paddy	Potato	Chillies	Groundnut	Net Income
Maha	3	0.8	—	—	Rs. 5280.00
Yala	3	—	0.9	0.9	Rs. 3640.00
					Rs. 8920.00

This plan produces a net income of Rs. 8920/- utilising land, labour and capital almost fully in the Yala but leaving 1.2 acres of land and 45 man days unutilized in the Maha. Capital proves to be the restrictive resource.

If potatoes are not included in the plan, then the optimal enterprise combination works out as follows:

	Paddy	Maize	Chillies	Groundnuts	Net Income
Maha	3	0.8	—	1.2	Rs. 3075.00
Yala	3	—	0.9	0.9	Rs. 3640.00
					Rs. 6715.00

The net income under this plan works out to Rs. 6715/-. Land and labour are fully utilized in the Maha but capital amounting to Rs. 610/- is left unutilized in the Maha. The Yala programme utilises all resources more or less fully.

The cropping programmes considered above are all based on the assumption that only the 3 acres of irrigable lowland were available for paddy cultivation. If however the irrigable highlands can be made to support paddy, the cropping pattern undergoes significant changes. At the lower level of resource supply, the optimal plan is as follows.

	Paddy	Net Income
Maha	3.75	Rs. 3000.00
Yala	3.75	Rs. 3000.00
		Rs. 6000.00

This plan produces an net income of Rs. 6000 which is less than the plan incorporating potatoes but higher than

the other alternative. At the higher level of resource supply, the most profitable enterprise combination, potatoes excluded, yields a net income of Rs. 8310.

	Paddy	Onions	Net income
Maha	5	—	Rs. 4000
Yala	4.4	.6	Rs. 4310
			Rs. 8310

This combination may not prove to be feasible in which case the entire acreage would be given over to paddy. The net effect on incomes by leaving out paddy from the Yala programme was also considered. This is only possible if soil conditions permit other irrigable crops in the lowland. The highland is assumed to be unirrigable.

The optimal plans for the Yala at the two levels of resource availabilities are shown below:

	Chillies	Groundnuts	Net Income
Yala (1st Level)	1.2	—	Rs. 1200
Yala (2nd Level)	1.3	1.7	Rs. 1940

Capital is limiting in the first plan whereas land is the limiting factor in the second plan. If however it is assumed that the highland allotment is irrigable in Yala, then the optimal plan is as follows:

	Chillies	Groundnuts	Net Income
Yala	1.1	2.6	Rs. 2075

Labour and capital are restrictive in the above plan but 1.3 acres of land is left unutilized. The net income position in these cases is much below the plans which include paddy in the Yala programme. Net incomes for plans including paddy are Rs. 2780/- and Rs. 3640/- for the two levels of resource availabilities respectively.

The above plans illustrate the value of the linear programming technique in reaching maximum profit given varied farm and resource situations. It would have been impossible to handle so many different alternatives by means of budgeting and there would be no guarantee that the optimum income position would be reached.

It must however be mentioned here that the primary objective in this exercise has been to demonstrate the use of the linear programming technique and draw broad generalizations rather than to compute optimum income positions for use by individual farmers. It is worth repeating that the plans are only as good as the data on which they are based. One cannot feel too happy about the input–output coefficients that are available in Ceylon for use in such exercises. But it is felt that the technical coefficients used here are reasonably accurate. Since the farm plans refer to certain typical farm situations, they should provide broad generalisations of use to policy makers, administrators and extension people.

PRACTICAL IMPLICATIONS.

Before going on to consider the practical implications of the various plans presented above, something must be said about the present cropping patterns followed in the Dry Zone colonies by way of comparison. Two factors that compel attention are the predominant position occupied by paddy and the relative neglect of the highland allotments. Throughout the Dry Zone, wherever adequate supplies of water are available, paddy is the peasant crop in the lowlands both in the maha and yala. Farmers go further and asweddumize portions of their highland allotments to bring it under paddy whenever opportunities for irrigation present themselves. Highland allotments are mostly unirrigable at present and do not support any seasonal crops in the yala. But the opportunities for growing rain-fed crops in the maha are also not availed of.

Extension activity at present is mainly directed towards inducing peasants to adopt improved methods of farming with regard to paddy production. But increasing concern is also being shown at the apparent under utilization of land resources and efforts are being made to induce farmers to grow other crops such as onions and chillies. This it is hoped, will not only help increase incomes but also enable a better utilization of water. Unfortunately, it was not possible to introduce water as a restrictive resource in the programmes above due to insufficient data. But experience suggests that problems of water availabilities do not concern the farmers too much. They would rather grow paddy with the attendant risks than grow other crops which need less water.

The cultivation of seasonal crops in the highland depends on lift irrigation and considerable investment is being planned to provide such irrigation. Moreover, farmers are also being induced to change to high value crops wherever feasible in the belief that this would increase incomes. It is against this background of the attempts being made to diversify the cropping system that the various plans presented earlier should be considered. Given the assumptions regarding yields, costs and prices, they seek to provide the optimum enterprise combinations.

One fact that seems to emerge from these plans is that the farmers in the various colonization projects seem to be operating much more rationally than most people would concede. Their preferences for paddy, while it may be traditional, is supported by current cost-price relationships. The optimum plans for the low level of resource supply assumed indicate that all lands suitable for paddy should be brought under paddy. The attempts of farmers to asweddumize even highland allotments wherever possibilities present themselves, as seen in the various colonies, also seems to be economically justified. The plans indicate that only small extents would be brought under other crops such as chillies. This again is in line with what farmers are attempting to do. Very few farmers at Elahera, for instance, cultivated subsidiary food crops. But wherever they did so, they seemed to prefer chillies and devoted only about quarter to half acre. The plans also indicate that net incomes of farmers who do not grow paddy is much lower than farmers who have paddy in their programme. This may explain why attempts made at Elahera to persuade farmers to grow subsidiary food crops in the Yala in order to conserve water have met with so much resistance.

Even when a higher level of labour and capital supply are assumed, paddy still continues to be the most important single crop. There is however a better utilisation of the highland allotments and this leads to higher levels of income. It is however significant that even high value crops such as chillies and onions do not lead to a shift away from paddy. Paddy would in fact replace these crops given the opportunity.

Given the lower level of resource supply, it appears that labour and not land is the factor limiting increased production and higher levels of income. This may appear surprising, but as the Elahera survey again indicated, considerable amounts of hired labour are required by the average farm family. Farmers will be forced to hire additional labour in order to increase incomes and difficulties in hiring labour may rule out intensive cash crop farming.

While labour is the restrictive resource in certain months, it is not fully utilised over the full year, thus indicating considerable under-employment. At the lower level of labour supply only about 480 men days out of the 900 assumed available are utilised. Given a situation in which labour is the limiting factor, one might think of mechanisation as an alternative. The problem is however complicated by the fact that labour is restrictive only in certain months. Moreover, mechanisation implies the substitution of capital for labour and capital itself is not in plentiful supply. There may however be a case for releasing labour from paddy for cash crop production.

The various plans presented here indicate the general approach to problems of increasing productivity and raising levels of income in certain typical farm situations. It must be emphasised that the conclusions derived can be nothing more than generalisation and approximations. But they do at least indicate that present plans for diversifying cropping patterns and providing lift irrigation to highland allotments require further study. They also point out to the fact that farm decisions have a firmer economic basis than commonly thought of. It is also hoped that these plans will illustrate the use of the linear programming techniques under conditions of peasant production. While it may be impossible to use this approach for individual farm planning, valid generalisation may be made for homogeneous areas and such plans could point the direction in which development activity should proceed. Dependance on technical knowledge alone may lead to the wrong decisions and it is important that the economic variables be also taken into consideration. And finally, it is hoped that the need for accurate input—output coefficients is sufficiently well illustrated. Accurate data fed into linear programming models could provide valuable information on which to base policy decisions relating to agricultural development.

It is important that such studies be made available rapidly so that policy makers do not operate in the dark as they very often do now.

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THE EVALUATION OF AGRICULTURAL MACHINERY IN CEYLON.*

V. E. A. WIKRAMANAYAKE.

POWER and machinery are an essential requirement of Agricultural Development in Ceylon, especially since mechanisation is the only way in which the pace of development can be increased. The two essential requirements of mechanisation are good judgement and good machines, and these requirements can be met only if an organisation exists for the evaluation of machines. The situation at the present time is best summed up by the following observations made in the interim report of the Tractor Committee appointed by the Ministry of Agriculture. "There is at present no tested data in terms of which the relative merits of different makes of tractors and implements used in Ceylon can be evaluated. The constant evaluation of all types of Agricultural machinery and the public availability of the results of such evaluation, is one of the most important functions of a governments' Agricultural service. In Ceylon, this responsibility has been placed on the Department of Agriculture. We regret to state that the Department has singularly failed to discharge this responsibility and indeed underline the inability of the Department of Agriculture to provide, at the present time, any reliable conclusions regarding machinery on which a policy of importation can rest. In this situation there is a danger that the opinions of sellers of machinery about their own products can be taken as a substitute for our opinions. This danger must always be safeguarded against in an underdeveloped country like Ceylon which must perforce be at the receiving end of the products of technologically developed countries." In Ceylon, Agricultural Research is well organised, staffed and provided for with up-to-date facilities. Significant advances have been made in many fields of agricultural development. The one field in which research has been conspicuously absent is the field of mechanisation although Power is one of the most

important factors in the complex of factors necessary for Agricultural Development.

It is an inalienable right of any country importing such an important commodity as Agricultural Machinery, to satisfy itself about the suitability of its imports for local conditions. The evaluation of agricultural machinery is the primary function of research, and research in mechanisation problems can be developed by the immediate organisation of a unit for the testing and evaluation of agricultural machines. Such organisations, variously known as "Farm machinery Institutes", "Research centers" etc., are functioning in many countries, both developed and developing. In manufacturing countries they serve to ensure that the machines are built to a minimum standard and provide information for the guidance of prospective importing countries. In non-manufacturing countries such testing will indicate the suitability of imported machines for local conditions and ensure that foreign exchange is not expended on machines of doubtful suitability. The tests are obligatory for all importers and are performed at their expense. In many countries the testing institute is able to support a considerable portion of their research programme from the revenue obtained from this service. The Nebraska tests (U. S. A) and the N.I.A.E. tests (U. K.) are well known and their results are readily available. These tests, however, are mainly confirmatory tests of the mechanical specifications of the machine, and do not relate to their field performance, the requirements of which will vary from country to country.

TESTING PROCEDURE.

In an importing country like Ceylon, the first consideration will necessarily be the amount of foreign exchange involved in the purchase. In the case of tractors, this will be generally proportional to the horse power, and therefore it will be pertinent to examine this question. Among any agricultural field operations the highest power requirement is for preparatory tillage, both for wet paddy and for highland cropping. Recent developments in the utilisation of two wheeled tractors of small horse power (especially those on rotary tillage) have resulted in satisfactory preparatory tillage being possible with such tractors. An analysis of the costs of five categories of tractor that can be used in the country are provided in Table 1. The field operation (rotary tillage) is the same for all four types and the cost per acre is significantly lower for the power-tiller class. Fourwheel tractors are capable of a faster working rate, and will be preferred by operators who wish to work larger extents of land. The four-wheel tractor is moreover a good substitute for the lorry for short haul transport, and indeed is being widely used at present for this purpose. On the basis of this analysis it will be advantageous to pursue the possibilities of organising mechanisation of small holdings based on the power tiller. (*N.B.* — The Power Tiller referred to is a two-wheeled walking tractor with a powered rotary tilling devise attached behind it.)

The field test has to be aimed at evaluating the performance of the tractor or machine under local conditions in producing the type of performance determined by local requirements. This test has therefore to be geared to the evaluation of the results of operation (for tractors and tillage machinery it will be necessary to measure field conditions before and after the test; for threshing machines, the threshing and separating efficiencies, percentage of broken grains etc.) as well as to the rate of working and costs.

It is necessary that these tests be standardised in every respect to minimise any possible advantage one machine may show over another due to a different type of test being used for each. It is also essential that the test report provide a maximum of quantitative information, and an absolute minimum of descriptive information which must necessarily be subjective.

It will be necessary also to set out standards that will have to be reached by a machine to qualify for importation. These standards will have to be modified as progress is made in research on Farm machinery utilization.

THE TESTING INSTITUTE.

The establishment of the Testing unit as early as possible will not be difficult. Our most urgent requirement is information on the field performance of prospective imports. It will therefore be necessary for a start to restrict the activity of the unit to field testing and issue field test

reports of as many machines as possible in the shortest time possible. Much of the instrumentation for this purpose can be turned out locally and with the cooperation of bodies like the Faculties of Agriculture and Engineering of the University of Ceylon, use can be made of some of their equipment and facilities. The unit can be gradually built up into a full-fledged research centre with full facilities for research on the modification of implements to suit local conditions, the design of new machines and the laboratory testing of locally manufactured machines. This unit will in time, be in close liaison with the extension services and can organize training courses in machinery utilization, maintenance and repairs for the extension services.

As the unit develops it will be able to coordinate its work with other fields of Agricultural research particularly Agronomy, Agricultural Economics and Farm Management and thereby make a positive contribution to Agricultural Development. At present the so-called Agricultural Engineering Division of the Department of Agriculture is merely an organisation set up for providing the various units of the department with engineering services of one kind or another. Research and Extension have never been its function nor inclination.

THE MAINTENANCE OF SUPERVISON OF TRACTORS IN THE FIELD.

Data on the performance of tractors now in the field is sadly lacking. It is most important that an assessment be made of the various aspects of costs involved in tractor operation. This type of study has never been done in the country. In the interim report of the tractor committee it was recommended that new makes of 4 - wheel tractors imported be used in tractor pools run by the importers. This should provide the starting point for making studies of costs involved. This function can be performed by the proposed unit, which would undertake detailed studies of the operation of the various tractor pools in order to obtain the following information.

(a) The cost of maintaining tractors and of using them for the different types of work they will be called upon to perform.

TABLE 1.

TABLE 1.

ESTIMATION OF COST OF ROTARY TILLING A PADDY FIELD (COMPLETE PREPARATORY TILLAGE) WITH FIVE TRACTOR TYPES.

		Symbol and Units	Formula	Riding Tractor (4-wheel) with Paddy field wheels and Rotary Tiller.			Walking Tractor (2-wheel) with Paddy field wheels and Rotary Tiller.	
				45/50 h. p.	35/40 h. p.	20 h. p.	Kerosene 5/6 h. p.	Diesel 6/7 h.p.
1.	Purchase Price	P Rupees	—	23200.00	20700.00	15000.00	3500.00	3800.00
2.	Rate of Working	acres/day	—	5	4	3	1.5	2
3.	Life Span	N Years	—	10	10	10	7	7
4.	Work Span	T Hours	—	10000 *	9000	9000	4000	5000 *
5.	Total Fixed Cost	a Rupees per hour	$a=\frac{P(1+\gamma)^N-d}{T}$	5.86	5.83	3.75	2.00	1.73
6.	Trade-in Value	d Rupees	d=0.1P	2320.00	2070.00	1500.00	350.00	380.00
7.	Repair Costs	r Rupees per hour	$r=k\frac{P}{T}$	2.09 k=0.9	2.07 k=0.9	1.50 k=0.9	0.38 k=0.45	0.43 k=0.45
8.	Full and Lubrication	f Rupees per hour	—	1.76	1.40	1.15	0.15	0.22
9.	Labour Cost	l Rupees per hour	—	0.75	0.75	0.75	0.50	0.50
10.	Additional Costs	i Rupees per hour	i=0.3 (a+r+f+l)	3.13	3.10	2.30	—	—
11.	Management Cost	m Rupees per hour	m=(a+r) 0.8	6.35	6.30	4.20	—	—
12.	Interest	γ	—	0.10	0.10	0.10	0.10	0.10
13.	Total Cost	Y Rupees per hour	Y=(a+r+f+l+i+m)	19.45	19.45	13.65	2.93	2.88
14.	Cost per Acre	Rupees per acre	—	31.90	38.90	36.50	15.50	11.50
15.	Tilling Capacity §	Crop acres/year	—	200	160	120	60	80

* Allowing for work done at a rate lower than full power.

§ Assuming 40 days available per season for two seasons.

N. B. The Coefficients used in working out some of the cost components are the result of the studies of several hundreds of tractors in Japan and Taiwan. No such coefficients have been worked out for Ceylon.

(Purchase prices used are pre-FEEC-scheme prices)

(b) The determination of analytical procedure for obtaining information on various cost components eg. repairs, maintenance, management etc.

(c) The minimum number of hours of economic use per year for each make and category of machine.

(d) The most desirable organisational set-up for machinery operation.

(e) The suitability of machines of various makes and categories for field operation, based on the above.

(f) The regulation of hire charges to cultivators based on the studies made.

The work of supervision envisaged will necessitate a great degree of control over tractor pools by the government, to enable the research unit to obtain all the data it requires. This is not unreasonable considering the importance of this activity to Ceylon's Agricultural Development.

These studies could also be made on privately owned tractors and on government tractor pools as well. At present such information relating to the many tractors of various makes now used by the government Department of Agriculture is not available. It will be possible to enlist the cooperation of the divisions of Agricultural Economics, Farm Management and Agricultural Engineering of the University of Ceylon in the collection and analysis of this data.

By no means least important of the information that can be obtained from such supervision, will be the posing of problems for research.

The functions of the Research unit can then be summarized as follows: The immediate functions will be

(A) To test the various makes of machines now imported and to publish quantitative test reports of them on the following broad basis.

FOR SOIL ENGAGING MACHINES.

1. The field description before the test. Such a description to provide quantitative assessment of soil characteristics, weed growth, stubble etc.

2. The effect of the tractors' use on the soil. Quantitative estimations of the degree of soil inversion, degree of pulverisation of soil (clod size) and degree of incor-operation of weed and crop residues and depth and width of work.

3. The rate of working and percentage of time required for turning at headlands.

4. Consumption of fuel.

5. Frequency of bogging down (if any) and the descrip tion of soil conditions at these spots.

6. Ground drive travel reduction during operation.

Tests for non soil-engaging machines such as threshers and reapers will have to be similarly based on the measurement of the quality of the work done.

In addition to the short test it will be desirable to work the machine continuously over a period of a few days in order to observe any shortcomings in design and to work out costs of operation.

(B) To make detailed studies of the operation of tractor pools, both government and private and as many private operators as possible in order to obtain information on costs of operation and repairs, manage-ment problems and such other information that could guide users in the selection of machines and organi-sation of mechanisation.

(C) To develop facilities and techniques for laboratory testing of all agricultural machines.

As the unit develops in scope of operation and experi-ence it will be a full-fledged Mechanisation Research Centre which will undertake the design and improvement of all agricultural machines and a continuous programme of testing and evaluation, and other studies.

In addition it will be in close liaison with the exten-sion services and will organise and conduct training courses in operation, maintanence and repairs at various levels.

At first sight the project would seem to be over-ambitious, but on close examination it will be seen that facilities and personnell now available in the country in the Department of Agriculture and the Ceylon University, could be made use of, if a meaningful scheme of coopera-tive endeavour can be worked out. A greater degree of Government control of imports and of organisation of mechanisation is essential, but this can hardly be considered objectionable considering the importance of Power in Agri-cultural Development.

** Since this article was received, an Agricultural Machinery Designs and Testing Centre has been established at Maha Illup-pallama by the Government Department of Agriculture — (Ed.)*

THE DEVELOPMENT OF MANAGEMENT PRACTICE RECOMMENDATIONS FOR RICE PRODUCTION AND RESEARCH

J. C. MOOMAW

MANAGEMENT is defined as the art and science of utilizing resources efficiently to produce a desired product. Farm management is the utilization of natural resources such as plants, soil and water to produce maximum economic returns from agricultural crops. Farm management and the management of agricultural research experiments places high value on the decision-making process (Castle and Becker, 1962). Several aids to making decisions in growing rice crops have been developed in recent years and are being used to maximize yields in rice farming and to reduce the variability of experiments in rice production research.

Approved cultural practices have been the mainstay of official agricultural Extension Services in many countries of the world, but are usually general in the sense that practices are recommended to be applied only when the problem has been specifically identified. Thus an insecticide is recommended for the control of a specific insect species or fertilizer practices are developed for special soil types or problems. For some practices, however, it is possible to make recommendations that apply to a crop widely grown in a relatively uniform environment as is flooded rice in the tropics.

These aids to management have been called "Standard Cultural Practice Recommendations" (Anonymous, 1968) and have been developed at two separate levels: one for the research worker, in which a high level of input is recommended without undue regard for the costs, and a second, which is intended for practical farmer use, in which careful attention is paid to the cost and return relationship for each of the

inputs recommended. The development of Standard Cultural Practice recommendations can be said to serve as the core of the agronomy research program at the International Rice Research Institute. It should serve as the framework for adaptive research programs elsewhere.

In Asian countries where most of the world's rice is grown, literature on the way to grow rice has generally consisted of lengthy and complex tomes or in other cases has been over-simplified because the assumption is made that every one knows how to grow rice. It has proved to be particularly important to make concise information available to the scientific research specialists who have insufficient opportunity or interest to study and practice the farm skills that are necessary for producing satisfactorily high yields. In the last five or six years it has become imperative that rice research workers develop these skills or acquire them through others, if they are to make their work credible internationally or to obtain yields as high as those obtained by the better farmers in every Asian country (Romulo, 1968).

The principal features of the current series of Cultural Practice Recommendations are that they are integrated over the period of the crop, that they are revised at the end of each series of experiments, and that they are of the greatest technologic efficiency that has been clearly demonstrated in rice experiments from any reliable source. An important feature of a practical Cultural Practice Recommendation is that it be economically evaluated in order that the cost/benefit ratios of the management practice are high both individually and when integrated into a management package so that they can be expected to give high returns to the farmer with good reliability.

The construction of Standard Cultural Practice recommendations takes place in two stages. Firstly, the factors of management are considered independently and these factors are then the principal objectives of field experiments. Experiments are designed to give specific answers to questions concerning intensity and capacity factors with each of the practices. The results of these experiments then are selected and organized to fit the steps in crop production as they occur in the growth cycle of the plant. The factors of

management are both environmental and cultural and they are listed below with brief comments about them and their relevance to the production function:—

1. LIGHT:

Light is an environmental factor that is completely uncontrolled by man. Dry matter production or net photosynthesis is largely determined by crop and soil management practices that lead to maximum use of net radiation (Bertrand, 1966). In the farm management sense, there are substantial changes in crop timing that can result in large gains in the availability of light for photosynthesis during the critical flowering and filling stages of the rice crop. When this is taken advantage of by proper time of planting, the utilization of light can be said to be a management factor (Moomaw, Baldazo, and Lucas, 1967).

2. WATER:

Water also is relatively uncontrolled by man as rice culture is in fact practiced in most of Asia, since so much paddy land is provided with neither irrigation nor drainage. Much of it, however, has bunds around small paddies in which rain is collected and conserved for the use of the (rainfed) crop. Where irrigation water can be controlled and provided on a regular and regulated basis, many experiments have shown that water at a 1 to 2 inch depth, if maintained continuously throughout the life of the crop, will be sufficient to provide the advantages of flooding both to the plant and to the soil, and generally, will bring about no detrimental effects on the tillering capacity or lodgi g incidence of the rice plant (Chow, 1953) (Murakami and Vignaraja, 1966; IRRI, 1966;).

3. PLANT AND DISEASE:

Current research has shown that improved plant types that are short, with stiff straw and erect dark green leaves are substantially more efficient in the conversion of sunlight energy than the traditional tall, leafy, lodging-susceptible rice plant that has been grown traditionally (Beachell and Jennings, 1964; IRRI, 1967). It is important that recommendations be made for the best-yielding plant material available. The problems associated with recommending dwarf varieties for specific locations are generally few owing to the wide adaptability and the moderately good disease resistance demonstrated by these varieties, especially IR—8. Varietal resistance is the most economic avenue for reducing yield losses to disease since application of chemicals for the control of bacterial and fungus diseases of rice have been generally unsuccessful in commercial practice. Some exceptions to this, represented by the use of chemicals for amelioration of the Blast disease and for the control of virus diseases by controlling the insect vector have been demonstrated.

4. SOIL AND FERTILIZER MANAGEMENT:

Problems of soil fertility are substantial in most of the rice growing countries of Asia. In the Philippines, relatively fertile soils derived from volcanic materials have resulted in high yields generally obtained with low amounts of fertilizer. The results from fertilizer experiments in Taiwan, in contrast, have consistently shown that all three of the major nutrients are required and that the timing of nitrogen application at intermediate periods during the crop growth (top dressing) have resulted in consistent yield increases throughout the island. This can be demonstrated repeatedly in other Asian countries. The response to top dressing of nitrogen is generally associated with soil textures that are coarse, with low levels of organic matter and low exchange capacity, while the problems of response to phosphorus and potash are primarily derived from the chemical characteristics of the soil parent materials, or their age and weathering history. The timing and amounts of nitrogen fertilizer are important functions of the plant type as well as soil factors. In general, split doses of nitrogen are advantageous with tall, leafy, weak-stemed traditional varieties, while with short, stiff-strawed erect-leaf varieties, the entire seasons supply of nitrogen can be applied at planting time in clayey soils and will remain available to the plant, while this technic results in substantial losses of nitrogen from sandy or silty soils.

5. STAND ESTABLISHMENT:

Stand establishment can be divided in to two component subjects, namely tillage and planting methods. Tillage technics are varied and in the rice growing areas of the

world, generally primitive. A few countries have developed mechanical methods and are using either two wheel or four wheel tractors for a substantial portion of their soil preparation. The principal problem of utilizing machinery in rice soils are those associated with traction in deep, wet soils and with floatation which is also required in puddling. These are clearly engineering problems and research is going forward in this area.

Planting methods also vary widely in Asian agriculture from broadcasting dry seed on dry soils to transplanting seedlings two months old in deep water. Perhaps as much as $\frac{1}{3}$ of the rice area in Asia is devoted to upland or highland paddy in which rice seed is sown dry in soils that have been cultivated in the dry condition, but by far the larger portion of the land is prepared wet after the beginning of the monsoon rain. This is normally done with animal power but soil is also prepared by hand and with tractors to produce a smooth even puddle into which plants are transplanted or upon which soaked seed is broadcast. In areas where broadcasting is successful there usually is opportunity to provide drainage of the surface of the soils for a period of time immediately after sowing.

6. INSECT CONTROL:

Insect control is an important variable in rice culture that has only recently been shown to be suitably provided by modern chemicals. The insect problem is one that is particularly variable since insect populations fluctuate widely over time as well as over relatively small areas. The use of Gamma BHC for the control of the rice stem borer and the use of diazinon which has given control of the borer and paddy leaf hoppers has developed in recent years through the work of the International Rice Research Institute and rice research workers in Japan. These materials, either of them alone or in combination with other insecticides which will control insect pests that are peculiar to the locality frequently have given returns on investment of over 200%. On the average, in tests conducted in the Philippines in 1964 and 1965, the cost: benefit ratio was 4 : 1 (IRRI, 1966).

7. WEED CONTROL:

Weed control practices fall in a special category because modern technology supplies chemicals which compete directly with hand labor. In some countries the labour supply is ample and the weeding is done both well and on time. This combination is rare enough however so that some weed control chemicals definitely have a place in Asian rice production. Economic considerations of course are stringent and the chemicals that eventually become successful must supply a degree of control that cannot be supplied by hand or must permit the weeding to be done in a more timely fashion so that yield responses and labor savings make a real contribution to individual farmer income. This requirement precludes the use of several of the expensive and sophisticated selective weed control chemicals except where rice is grown broadcast or seeded directly by other methods. The most promising chemicals at the present are the phenoxyacetic acid materials, either 2, 4-D or MCPA, which when used effectively, are the lowest cost and most effective chemicals presently available. New, cheaper, selective weed killers are becoming available but the weed control practices will continue to rely heavily on use of phenoxyacetic acids.

Mechanical devices in addition are making some contribution. The Rotary Weeder can reduce the requirements for hand labor remarkably but it is more effectively used when rice is transplanted or sown in rows and when the labor supply is limited or poorely distributed. Since mechanical devices do not weed within the hill or between closely spaced hills as chemicals are able to do, the advantage may still lie with chemical methods.

8. HARVEST AND THRESHING:

Problems of harvesting and threshing are generally engineering problems particularly with regard to the mechanical devices that are being developed for small scale use. However, several other problems, such as the timing of harvest for maximum yields and the breeding problems associated with premature shattering or shedding are problems that can be handled agronomically and that management does affect in a marked manner. The timing of drainage of the paddy before harvest is one of these management practices.

Once the management practices to be tested are determined by a researcher or organization their practicability must be further examined by economists and extension workers in the light of local conditions that may affect their adaptability to real farm situations that normally vary among soils and environmental conditions. The economic criterion must be applied in terms of the whole package of practices and in some cases practices that are of only marginal effectiveness or marginal economic advantage may be useful provided they have "insurance value" and are combined with other practices that return high profits to the individual farmer. Making recommendations on purely theoretical scientific premises has in general proved to be unsuccessful, since farmers rightly refuse to adopt them without demonstration of practical benefits.

In making Cultural Practice Recommendations for research farms, the criteria are somewhat different. Cultural practices on experimental farms are designed to protect a large investment made in the design, lay-out and conduct of replicated experiments, which greatly excedes that made in non-replicated trials and farmer fields. Insect control, for instance, must be as good as can be provided in order that treatment effects in a fertilizer experiment, for example, are not obscured by insect attacks that may be determined to some degree by the fertilizer treatments. A false result can easily be obtained. In plant breeding trials, soil and nutritional problems must be controlled and adequate nutrients supplied if superior plant materials are to be indentified. In the absence of surplus nutrients, the selection becomes a special one for conditions of poor nutrition and superior-yielding varieties are not identified. It is then apparent, that the economic criterion for the use of either fertilizer or insecticides as inputs is not of first consideration in research fields or farms.

A further criterion for the development of Cultural Practice recommendation in either category is that they must be flexible. At the Intetnational Rice Research Institute, some categories of practice (tillage, for instance) have not been changed from those that are traditionally practiced since these practices have not been improved. In other categories, such as insect control, the recommendations are changed every cropping season or sometimes even in the middle of a crop when a new, effective material is identified in the research program or a new method of applying it becomes known and sufficiently available so that it can be utilized immediately. Quite normally, different recommendations are made for wet season and dry season. The wet season recommendations usually include lower amounts of fertilizer nitrogen since the limited sunlight prevents maximum utilization of nitrogen. The dry season problems with insect control may be substantially more difficult than they are during normal planting season when the area planted is large enough to dilute insect problems and they are then not concentrated on small experimental plot areas.

Examples of the kind or recommendations that may be useful are provided by IRRI General Leaflet No. 1 (IRRI, 1968) and in the research category by similar publications (CARI, 1967).

This classification and development of cultural recommendations can be applied to other crops in greater detail than has been done in the past.

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FERTILIZERS AND RICE PRODUCTION

DERVIN M. RODRIGO.

AT the symposium of April 1966, on "Research and Production of Rice in Ceylon," organised by Section B of the Ceylon Association for the Advancement of Science, I expressed the view that "Rice is pre-eminently the need of the day and is very likely to be even more the need of the morrow," (1) this was before the present Rice Crisis. That morrow has now come, precipitated by a world shortage of rice. The government was compelled in Mid-December 1966 to reduce the rice ration by half, *i.e.*, from 4 pounds to 2 pounds per person per week. As a result the interest hitherto taken and the importance and urgency which until now had been attached to rice production were greatly accelerated. It may be recalled that it was only after the World War II (1939) that Food Production in Ceylon received any serious attention. Since Ceylon regained its independence in 1948 successive governments introduced progressive measures and provided liberal incentives for increased rice production. From this time on strenuous efforts were made by the Department of Agriculture to increase food production and special attention was paid to rice cultivation both by the institution of research studies and by the provision of extension services for the dissemination of knowledge pertaining to rice cultivation with special reference to the use of good seed, fertilizer practices, weed control, cultural practices, and protection of the crop from damage by pests and diseases.

The importance of science as the basis of modern agricultural development has now gained universal acceptance. During the last hundred years or so science has provided modern agriculture with the techniques of the rational use of fertilizer, improved varieties of seed, better control of plant diseases, insect pests and weeds, and improved tillage and cultural practices. These are without question the vital

pre-requisites for any programme of increased food production and it is largely through intensive scientific research and necessary technological advancements that we can hope to march towards the cherished goal of self-sufficiency.

RATIONAL USE OF FERTILIZERS.

Before World War II the use of fertilizer in rice cultivation was the exception rather than the rule. Where fertilizer was used at all, it was only in the form of bone meal. In 1950 the Department of Agriculture, having conducted a series of experiments, recommended 3 fertilizer mixtures, one for the Low Country Wet Zone, one for the Dry Zone, and the third for the sandy tracts of the Eastern and Northern Provinces and other similar areas. After further experiments the composition of these three fertilizer mixtures was amended in 1956 and the quantities recommended were substantially increased.

During the period 1956 to 1959 considerable advances were made on the existing knowledge of the Chemistry of Rice Soils and the Physiology of the Rice Plant and further information was gathered from fertilizer experiments conducted in farms and in cultivators' fields. The chemical regime in a flooded rice soil was found to be characterised by the following:— a deficiency of oxygen, an excess of carbon dioxide, markedly increased solubility of iron and manganese, absence of nitrates, presence of sulphides, increase in solubility of phosphates, increase in solubility of silica, and the anaerobic decomposition of organic matter (2). Further fundamental studies begun in 1958 (3, 4, 5) opened a new chapter in the study of the Chemistry of Rice Soils. It was discovered that the application of nitrogen fertilizer at the time of planting or sowing was unnecessary because when soils are puddled and submerged there is sufficient mineralization of soil nitrogen into the ammoniacal form of nitrogen to meet the nitrogen requirements of the rice plant during the initial stages of growth. In place, therefore, of the basal application, top dressings of nitrogen at critical stages of the plants' growth were proposed. These findings were adopted and put into effect in 1959, resulting in a more efficient utilization of nitrogen fertilizer and effecting a saving of several millions of rupees to the country. In 1959, as a consequence of these findings new fertilizer recommendations were made. Eight fertilizer formulations were now made, two for the dry-zone, 5 for the wet-zone, and one for soils of both zones low in active iron, *i.e.*, for sandy, kirimatta and peaty soils.

Since the 1959 recommendations further additions of an important character were made to the knowledge of fertilizer use in rice cultivation and the physiology of the rice plant. A team of Japanese Experts working in Ceylon urged the adoption of the concept of "Yield Components". At the same time the "All Island Rice Soil Fertility Survey" was completed in 1963. In view of the above developments there was a need for further rationalization of the fertilizer recommendations. Accordingly in 1964 specific fertilizer formulations were made covering each of the 22 administrative districts of the island.

Findings of recent experiments have revealed that higher levels of phosphorus are required for rice soils of Ceylon (6). Further the Ceylon Fertilizer Project (F.F.H.C.) has shown that there is a distinct advantage to be derived by using concentrated superphosphate in place of saphosphosphate in the Dry Zone. It was also revealed that local varieties of rice show a response to fertilizer applications when top-dressings of nitrogen are applied though not to the same degree as improved varieties. This revelation necessitated that there should be no distinction between improved and local varieties as far as fertilizer recommendations are concerned. Hence in August 1967 the fertilizer recommendations for the 22 administrative districts were further modified and rationalised embodying the above findings.

Investigations are continuing with the object of evaluating further the fertilizer responsiveneess of local and hybrid varieties of paddy and determining the relative efficiency of different forms of nitrogen, time of application of nitrogen, the use of compound pelleted fertilizer, silica, compost, and lime on rice soils. In the search for the attainment of self-sufficiency in rice investigations are continuing for further refinements of fertilizer recommendations with a view to

achieving maximum efficiency and economy. This is a continuous and an unceasing process.

Rice, undoubtedly, occupies a position of strategic importance in the economy of our country. It is no exaggeration to say that the nation's economic survival depends on how far we will be able to substantially increase rice production in the course of the next few years.

Dr. B. R. Sen, the Director General of the F. A. O., in his preface to the F. A. O. Publication "Crop Production Levels and Fertilizer Use" states that investigations conducted in many parts of the world "make it clear that any country which aims at increasing the production of food and economic crops must plan to increase the consumption of fertilizers".

The Government of Ceylon, fully alive to the benefits to be derived from increased use of fertilizer in rice cultivation for procuring higher yields, has made extensive financial provision for this purpose in the ensuing years. During the five year period from 1965/66 to 1969/70 as shown in the Agricultural Development Proposals for 1966 to 1970 (7), a sum of 277 million rupees or 74 percent of the total projected investment of 359 million rupees for increased rice production, is to be spent on the import of fertilizers, subsidies on fertilizers and in the construction of fertilizer stores.

The available evidence shows that in 1913 the average yields of paddy for the whole island was 15 bushels per acre. In 1938 the national acre yield was 21 bushels. Since then the yields have progressively increased and in Maha 66/67 the national acre yield was 40.85 bushels, while that of Yala 67 was 42.30 bushels. These are the highest national acre yields so far recorded. Today our national acre yield exceeds that of Burma, India, Indonesia, Pakistan, Philippines and Thailand. This is surely an achievement worthy of credit.

Application of fertilizers in the view of many competent authorities is capable of producing the greatest impact on increasing rice yields as has been convincingly demonstrated in many parts of the rice growing regions all over the world. In Ceylon too, trials conducted in numerous locations throughout the island have indicated that yields could be considerably stepped up by the use of artificial fertilizers. To achieve this it is essential that farmers should be convinced that greater prosperity could be achieved through yield increases in rice and that the simplest, easiest and quickest method is by the use of artificial fertilizers.

Rice growing differs fundamentally from other types of cultivation in that (a) the land is Prepared by a system of puddling for the reception of the crop and (b) the land is kept flooded and therefore saturated with water during the growing season. These two factors dominate the entire conditions under which paddy is grown, and their effect on the soil and the plant must receive careful consideration if application of fertilizers to rice is to be placed on a rational basis.

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THE FUTURE PROSPECTS OF THE TEA PLANTATION INDUSTRY IN CEYLON.

NIHAL AMERASINGHE.

THE Tea Industry is the mainstay of Ceylon's economy. Over 60 per cent of the country's foreign exchange is derived from the exports of tea, which could finance our entire imports of food and drink. Further, it contributes heavily to the islands revenue by way of direct and indirect taxes. (1) While production has increased by considerable amounts over the last few years, it is lamentable that the income derived from the industry has shown downward trends. (Table 1). This situation is indeed disconcerting, since, the economy is vitally linked with the success of the tea industry.

World consumption of tea has virtually reached saturation while vast possibilities still remain for expanding production. The current apprehension is whether the tea industry could maintain its eminent role as Ceylon's premier staple under these circumstances.

PRESENT TRENDS IN WORLD PRODUCTION.

1. Production in Asia. Asia accounts for 94 per cent of the worlds production of tea. (2) The traditional producing countries have been India, Ceylon, Pakistan, Indonesia, Japan, Taiwan, Iran and Malaysia. Production in Asia taking the 1960-62 average has been 1,653 million lbs. and the F A O projection for 1970 is 2,023 — 2,204 million lbs. (3) (Table 2). The total increase in output over the period is anticipated to be in the region of 22 - 33 per cent which would entail an annual growth rate of 3 per cent.

All these countries have concerted longterm and short-term plans for increasing output. Programs for increasing output by increasing the acreages under tea, as well as the more intensive use of cultivation practices such as fertilizer application and crop protection measures are being implemented in these countries. In view of these plans the production targets for Asia as envisaged by the F A O seem likely to be achieved.

2. Production in Africa. In recent years the East African Countries have made tangible contributions to world output. From a per world war 2 level of 2 per cent, African production today amounts to 7 per cent of the world output. Tea was first planted in East Africa in 1900, but was of little importance until 1950. Since, 1950, expansion of acreages and production have occured at an accelerated rate. The present acreage under tea in Kenya, Uganda, Tanganyika, and Mozambique amounts to about 200,000 acres. Soil surveys have revealed that a further 1.5 million acres suitable for tea cultivation still remain. (4)

According to the F A O projection for 1970, tea production in Africa would increase by 71 — 90 per cent over the 1960 production, and would amount to 13 per cent of the world output. (3)

3. Production in Latin America. The acreage under tea in this region has expanded rapidly since 1953, following the doctrine of import substitution. Production in this region amounts to 1 per cent of the world output and is mainly for domestic consumption. It is anticipated that the output would be around 42 million lbs. in 1970, which would be an increase of 58 per cent over the 1960 figure.

4. Production in Mainland China & the U.S.S.R. Very little statistics are available from these two regions. A preponderance of their production is 'green tea'. The production in these countries have been so far exclusively for domestic use, but a change in trade policy could result in the appearance of these teas on the world market in tangible amounts. However, currently green tea contributes only 2 per cent to the international trade in tea. (2)

World production would therefore continue to increase. According to the statistics of the F A O, world production in 1970 would be 2,268 — 2,470 million lbs. The increase

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in production is expected to take place at the rate of 3 per cent per annum. Rapid expansion in production is anticipated in the African and Latin American countries, which would result in greater production of ordinary grades of tea.

PRESENT TRENDS IN WORLD CONSUMPTION.

The world consumption pattern of tea could be classified into three distinct groups:

1. Consumption in countries with high per capita income.
2. Consumption in the Developing Countries.
3. Domestic Consumption in Producing Countries.

1. CONSUMPTION IN COUNTRIES WITH HIGH PER CAPITA INCOME.

In these countries the preference for any particular beverage is mainly a question of habit and custom. These change but slowly and per caput consumption is apt to remain fairly stable or show a gradual trend over a long period. The rate of increase in per caput consumption during the period 1960—70 as projected by the FAO is 1 per cent.

Surveys carried out in these countries reveal that, the income elasticities of demand for tea are lower than for any other beverage. Thus changes in income or price would be of little importance in changing the pattern of consumption in these countries, where habit is the chief factor which influences consumption. Recent trends reveal that per capita consumption of tea has declined, while those of other beverages, particularly instant coffee has shown an upward trend.

2. CONSUMPTION IN THE DEVELOPING COUNTRIES.

In the relatively poor countries changes in income, price of tea, and competition from other beverages have a strong influence on consumption. In all these countries significant changes in consumption have occured after the second world war. This is undoubtedly attributable to the rising levels of income associated with economic development. In the case of Iraq it was observed that consumption had risen by 196 per cent over the period 1948—50 to 1960—62 (7). Considerable expansions in other middle eastern markets have also been observed.

Hence, it is in the Developing nations that prospects for expanding consumption exist, where increasing incomes and populations would engender greater consumption.

3. CONSUMPTION IN PRODUCING COUNTRIES.

The per caput consumption in these countries is still low. Large, expanding populations and rising levels of incomes, make these countries important potential consumers for absorbing the increased output envisaged. At present, the consumption of tea in Ceylon amounts to 7 per cent of the total production. (5)

Thus considering trends in world consumption it may be surmised that consumption in the affluent economies would not change substantially unless dramatic changes in the forms of marketing tea or intensive sales promotion campaigns could make impacts on presest consumption patterns. It is likely that developing nations would absorb greater quantities of tea in the future due to their rising levels of income. There is also the possiblity of increasing the domestic consumption in producing countries. However, the increase in consumption envisaged would not keep pace with the rapid increases in production, and world production and consumption would be in imbalance by 1970. World production is likely to increase at the rate of 3 per cent per annum and would amount to 2,268 — 2,470 million lbs., while consumption would increase at the rate of 2 per cent per annum and would amount to 2,161 — 2,309 million lbs. (3)

THE OUTLOOK FOR CEYLON TEA.

The major buyer of Ceylon tea is the U. K. which imports 36 per cent of Ceylon's total exports. (6) The per capita consumption in the U. K. has declined from 10 lbs. in 1959 to 9 lbs. in 1965. (Refer Table 4). These figures when compared with competing beverages especially coffee, reveal a change in consumer preference. It was observed that there

has been a rapid growth in the consumption of coffee to a peak statistic of 2.9 lbs per head in 1963, which was almost treble the figure recorded in 1953 and four times the pre-war average. (8) The future of Ceylon tea may be further weakened in the British Market as a consequence of its proposed alliance with the European Common Market. If Britain joins the Common Market. Commonwealth preference would no longer exist and Ceylon would lose a considerable proportion of her market. The European Economic Community is already financing tea development in dependent territories in Africa which are already competitors for Ceylon tea in the European Markets, U. S. A., and Canada. If Britain enters the Common Market these African countries would enjoy preferential treatment and would have a further advantage in price over local tea due to the communitys 23 per cent external tariff which would make local tea more expensive.

The consumption patterns of other affluent communities have also shown downward trends. Although incomes have continued to increase the demand for tea has dwindled. The decline in tea markets in these countries could be attributed to three factors. They are:

1. Change in consumer preference with increasing disposable incomes to other beverages such as coffee and soft drinks.
2. The increasing competition from low quality teas which flood these markets and preclude consumers from buying genuine quality teas at reasonable price.
3. Insufficient International Marketing and Sales promotion activities.

The Developing Countries which have less quality conscious markets offer the best prospects for absorbing the increased surplus of ordinary grades of tea envisaged. The ordinary grades of tea from the Low and Mid country, which account for 60 per cent of the local production may find markets in these regions. However, the chances of Ceylon obtaining a compensatory increase of markets in these regions seem remote. India has already entered into trade agreements with the U.A.R., Sudan, Tunisia, Jordan and Israel. According to the International Tea Committee

74 per cent of Egypt's total imports of tea were supplied by Ceylon in 1948–50, and this amount had declined to 11 per cent in 1963–65. (7) On the otherhand supplies from India had risen from 13 to 64 per cent during the same period. Since 1958, Ceylon's exports to Sudan have almost ceased, while India's position has reached eminence. Statistics also reveal that exports to Israel and Jordan from Ceylon are falling at an alarming rate. Further, the South African Market which until a few years ago was dominated by Ceylon, is now being invaded by East African teas. (7)

Thus the future of Ceylon tea looks gloomy in the context of present trends in consumption. The recent devaluation of local currency cannot be expected to bring about dramatic changes in consumption patterns of the affluent nations, considering the fact, that consumption in these areas is insensitive to price changes. However, Britain may now buy more local teas, to strengthen its re-export trade. The developing Countries may also now opt to buy more local teas since they would be cheaper in relation to other teas. However it would be imprudent to suggest the gains to the industry as a result of devaluation at this stage and we would have to wait patiently to see whether cheaper local teas would result in larger exports.

The following policy measures, both longterm and short-term are suggested to ameliorate the present situation facing the tea industry.

1. RESTRICTION OF SUPPLY.

A restriction of supply of the quantities produced and marketed by the tea producing countries would no doubt help to restore the prices of tea. However, the prospect of an international agreement to restrict supply would be remote due to the sectarian interests of producing countries. A restriction of the local supply of tea in view of a lack of agreement by all producers would be therefore inadvisable. It would therefore be pertinent to examine what policy measures Ceylon should adopt in view of an imminent expansion of world output.

The quality and flavour of Ceylon tea is world renowned. The image of Ceylon tea noted for its exclusive quality

has been based on the Up-Country product which accounts for 40 per cent of the total production. These teas would continue to command premium prices and would be able to withstand any competition, since, the quality associated with it is largely an ecological attribute. The affluent economies would continue to demand high quality teas and it is imperative to maintain and enhance this quality.

It is for our Low and Mid Country teas that the outlook is disconcerting. The Low country teas are mainly demanded for their appearance, strength and colour of liquor. The Mid Country teas on the otherhand attempt at striking a balance between the characteristics of the up-country and low country product. As stated earlier the surplus of tea envisaged is largely of the ordinary grades. The local production of ordinary grades which originate in the mid and low country areas would therefore have to develop exclusive virtues if they are to combat competition from the other countries. If the claims of the Tea Research Institute to develop a 'super tea' becomes a reality, it would be possible to obtain high quality irrespective of altitude. There would then be some respite for our local ordinary grades. However, the development of such a product by the control of biochemical processes could prove to be a double edged weapon, since, other countries would follow suit and would not only compete for our low and mid country products but would endanger the markets for our quality upcountry teas as well.

2. MEASURES DESIGNED TO STIMULATE THE FINAL DEMAND.

The shift in consumer preference to other beverages, as observed earlier, could be largely attributed to the laissez-faire attitude towards tea sales promotion. Tea is one of the less advertised beverages. Between 1960—65, the average annual expenditure on advertising tea through the press and television was about 1½ per cent of consumer expenditure. while the comparable figure for coffee was 5 per cent.

Intensive sales promotion campaigns for tea in the U. K. for traditional black tea, as well as for instant tea would be a step in the right direction. Three fourths of the coffee consumers of the U. K. demand instant coffee and hence, intensive sales promotion activities for popular rising instant tea could prove beneficial.

In the U. S. per capita consumption is only 0.7 lbs. The high per capita income and the large populations in the U. S. hold promise for expanding tea consumption. (6) This is true for the other affluent countries as well. However, it is unlikely that conventional black tea with its laborious brewing methods would appeal to the high pressure living of modern society. Prospects for expanding tea consumption in these countries would be tied up with promotional activities for new forms of tea such as 'instant tea', 'tea bags' and 'iced tea'.

In the Developing countries too, it is imperative to carry out intensive sales promotion. In the centrally planned economies there are no sales campaigns of any sort and trade is entirely under Government control. All developing countries have large populations, rising standards of living and low per capita consumption. Sales promotion as well as trade agreements with these countries would help to relieve considerable amounts of the surplus of ordinary grades of tea.

Thus, the onus would be on the Tea Research Institute to provide the new forms of tea, as well as improve the conventional black tea. While the Tea Propaganda Board would have to perform the onerous task of intensifying their sales promotion campaigns to maintain and expand our markets abroad.

3. MEASURES DESIGNED TO REDUCE THE COST OF PRODUCTION.

In the light of expanding outputs of plain grades of tea and dwindling prices, the logical approach to withstand this adverse situation would be to reduce the cost of production. A reduction in cost would help to widen the margin between costs and returns or at least help to maintain the accustomed profitability in view of the erosion in prices. What must be appreciated is that every cent saved in the cost of production would mean a saving of Rs. 5.0 million to the industry, assuming production to be in the region of 500 million lbs.

The most costly items of expenditure are 1. Plucking 2. Weed Control 3. Fertilizer 4. Manufacture and 5. Packing materials.

These five major items of expenditure amount to over 75 per cent of the total cost of production. (Table 6). A study of the cost of production of 20 estates chosen at random from the three climatic zones in which tea is grown showed a mean value of Rs 1.48 per lb. of made tea, with a standard deviation of 5 cents. (11) Cost in the up country being slightly higher than in the low country.

Let us now examine the feasibility of reducing these items of expenditure which would ultimately determine the competitiveness of local tea.

1. **Plucking Cost.** The cost of plucking amounts to 35 — 40 cents per pound of made tea, and is the major item of expenditure. It is an labour intensive operation and accounts for 44 per cent of the total labour requirement. (Table 5). Plucking is an exacting operation and the quality of the manufactured product depends on it. The feasibility of mechanizing this operation with a view to economising on labour costs has proved to be disappointing. Mechanical harvesting gives coarse leaf and 'picking over' becomes necessary, to maintain good quality and does not result in any economy. (12) Thus, present mechanical devices for harvesting, leaves much to be desired and cannot be recommended without reserve. Increasing the yield per acre by planting high yielding clones could help in reducing the costs within narrow limits.

2. **Weed Control.** The cost incurred on weed control amounts to about 15 cents per pound of made tea. This operation accounts for 18 per cent of the total labour requirement. (11) In recent times chemical weed control has gained popularity due to the ability of chemicals to control weeds more effectively over long periods, economy of use and less destructive tendencies to the soil.

In a recent experiment carried out by the Tea Research Institute, there were no differences in yield observed between herbicide tested plots, hand weeded plots and unweeded plots over a period of six months. (13) If

this finding is applicable it would mean that conventional monthly weeding rounds could be dispensed with and would lead to considerable economies.

3. **Fertilizer Cost.** The expenditure on fertilizer amounts to about 17 cents per pound of made tea. (11) The response of yield to fertilizer application has been linear, particularly with reference to nitrogen and it is likely that with the breeding of high yielding clones, the application of fertilizer would have to be increased. The level of nitrogen during the last three decades has increased by 80 — 100 per cent and the upper limit has not been reached. (9) There is no possibility of economising on fertilizer use except perhaps on phosphorous and potash within limits as advocated by the Tea Research Institute. (14)

4. **Manufacture.** The cost incurred on manufacture amounts to about 25 cents. (Table 6). (11) Considerable economies in the use of modern innovations have been experienced. With the use of trough withering it was found that withering costs, fuelwise, could be halved and no difference in quality was observed in comparison to conventional tat withering. (15)

In the case of 'rolling' savings in rolling room labour costs by the installation of a 'Rotorvane – CTC' unit in preference to the orthodox system are largely offset by the cost of maintenance of a CTC roller. (9) Further, while the Rotorvane – CTC method of rolling to obtain better liquoring properties may be worthwhile in the higher elevations, it would not be advantageous for the lower elevation teas which are demanded for their appearance. (16) It would not be therefore possible to obtain economies by the technological advances in the method of rolling since, the modern innovations are based on improving the colour and strength of liquor rather than obtaining economies in manufacture.

In the process of fermentation, reduction in costs could be obtained by the use of trolley fermenting trays.

However, the ultimate use of these technological advances would depend on their ability to improve the quality of tea. It is imperative that caution be exercised

in the use of any technological innovations since the maintenance of quality is of prime importance. A saving of a few cents would be possible by the use of modern developments in the field of manufacture.

5. Packing Materials. The expenditure on packing materials amounts to about 10 cents. It is lamentable that local production of packing materials is below par. Considerable saving would result if local enterprise could provide the tea industry with good quality, cheap packing materials. It would be possible to save 3 – 4 cents as a result.

It is therefore apparent that under present conditions a saving of only about 10 cents per pound seem possible. Further economy may be possible in the expenditure on crop protection by the development of dual purpose sprays and also on green manure and shade, with the current advocacy of little or no shade. Besides the economies possible in these items of expenditure, the Overhead charges or General charges may be reduced by increasing the production per acre.

4. THE DEVELOPMENT OF BY-PRODUCTS OF THE INDUSTRY.

Diversifying the products of the industry would not only help to relieve the surpluses of tea but would also enhance the stability of the industry. The production of caffeine, which is used in soft drinks, essences and flavours of tea which may be used for flavouring ice cream etc., and the production of tea cider may be pursued. (17)

SUMMARY.

To sum up it may be stated that the world production and consumption of tea would not be in equilibrium by 1970. World production would exceed consumption by over 100 million pounds. (in 1970) The surplus being mainly in the form of ordinary grades of tea. Considering the factors influencing consumption in the countries with high per capita incomes it would be evident that increased consumption, especially of ordinary grades of tea would be unlikely. However the low per capita consumption and rising levels of income in the Developing Countries could lead to a greater consumption of tea.

The outlook for Ceylon tea is disconcerting in view of the shifting consumer preference to other beverages in the affluent economies and the trade agreements of other tea producing countries with the Developing nations. However, certain longterm and short-term measures could be adopted to alleviate the position. Intensive sales promotion campaigns, new forms of tea and trade agreements could stimulate the demand for Ceylon tea. Research should be geared to reducing the costs of production, improvement of quality, development of new forms of tea and the development of by-products of the industry. These measures would help to maintain and enhance the competition of Ceylon tea, and would provide the proverbial Silver lining to the cloud that looms large over the tea industry.

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STATISTICAL APPENDIX

Table No.

TABLE 1.

TEA PRODUCTION, EXPORTS AND PRICES

Year	Production Quantity Mn. lbs.	Exports Quantity Mn. lbs.	F.O.B. Price Rs./lbs.	Average Colombo Auction Price Rs. per lb. High Grown	Medium Grown	Low Grown	All Teas
1955	380	362	3.30	2.34	2.04	2.40	2.14
1957	398	368	2.78	2.05	1.61	1.88	1.86
1959	413	384	2.72	2.13	1.69	1.48	1.85
1961	455	426	2.62	1.99	1.72	1.83	1.83
1963	485	456	2.50	1.90	1.54	1.56	1.68
1965	503	472	2.51	1.93	1.65	1.64	1.75
1966	490	441	—	1.84	1.46	1.37	1.57
1967	520	493	2.50	—	—	—	—
1970	571	540	2.40	—	—	—	—

TABLE 2.

WORLD PRODUCTION OF TEA 1960—62 & 1970 (Projection)

1 Metric Ton = 2,240 lbs.

Production in Major Producing Regions	1960-62 average in '600 Metric tons	1970 Projection in '600 Metric tons	Overall increase 1960-62 to 1970 m. t	%Annual 1950-52 to 1955—57	Rate of Increase 1955/57 to 1960/62	1960/62 to 1970
Asia (India, Ceylon, Indonesia, Pakistan, Turkey, Iran, & Malaysia)	738	903—983	22.3—33.1	3.1	2.5	3.2—3.2
Africa (Kenya, Malavi, Uganda, Tanzania, Mozambique, Mauritius & others)	53	91—101	71.6—90.5	9.2	9.9	6.2—7.4
Latin America (Argentina, Brazil & Peru)	12	19	58.3	12.5	24.6	5.5
World Total Excld. U.S.S.R. & Thailand China)	803	1,013—1,103	26.1—37.5	3.5	3.0	2.6—3.6

From: Monthly Bulletin of Agricultural Economics and Statistics F.A.O. May 1965.

TABLE 3.

Latin America (Argentina, Brazil & Peru)	12	19	58.3	12.5	24.6	5.5
World Total Excld. U.S.S.R. & Thailand China)	803	1,013—1,103	26.1—37.5	3.5	3.0	2.6—3.6

From: Monthly Bulletin of Agricultural Economics and Statistics F.A.O. May 1965.

TABLE 3.

CONSUMPTION OF TEA 1955/57 & 1960/62 AVERAGES & 1970 PROJECTION

Country	1955/57 Average '000 metric tons	1960/62 Average '000 metric tons	1970 Projection '000 metric tons	Annual rate of increase 1955/57 to 1960/62 Percentage	Rate of increase 1960/62 to 1970 Percentage
1. Importing Countries					
U.K.	226.4	232.4	240.8	0.5	0.4
U.S.	45.2	53.3	57.5—61.1	2.9	0.8—1.5
Australia	25.3	28.0	32.1—33.5	2.0	1.5—2.0
Canada	20.2	19.3	21.6—22.9	-0.9	1.3—1.9
South Africa	11.9	14.1	18.1—20.3	3.6	2.8—4.1
Netherlands	8.3	9.1	8.9—10.0	1.7	0.2—1.0
NewZealand	6.7	7.5	8.5— 8.9	2.2	1.4—1.9
German Fed. Rep.	5.8	6.9	6.7— 7.5	3.4	0.3—0.8
UAR	15.7	22.8	30.9—34.6	7.7	3.4—4.7
Morocco	15.2	12.9	17.5—19.6	3.2	3.5—4.8
Iraq	13.2	18.7	25.9—28.6	7.3	3.7—4.8
Sudan	6.5	7.7	10.2—11.2	3.3	3.2—4.3
Total	467.8	515.3	561—584	1.5	0.9—1.4
2. Producing Countries					
India	100.4	130.4	174.7—192.7	5.4	3.3—4.4
Japan	61.0	71.6	90.7— 98.6	3.3	2.7—3.6
Pakistan	16.7	20.7	25.5— 27.6	4.4	2.3—3.2
Indonesia	8.6	12.0	15.2— 16.8	2.9	2.7—3.8
Ceylon	8.1	13.3	17.8— 18.5	10.5	3.3—3.7
Iran	13.5	18.0	25.3— 29.1	6.0	3.8—5.5
Turkey	4.5	10.6	14.7— 16.5	6.3	3.7—5.0
China (Taiwan)	4.3	5.4	8.2— 9.5	4.9	4.7—6.5
Malaysia	3.5	3.5	4.6— 5.0	—	3.1—4.0
Argentina	2.5	3.2	3.8— 4.1	5.1	1.9—2.8
Kenya	2.3	2.5	3.4— 3.8	1.7	3.5—4.8
Tanzania	0.9	1.6	2.1— 2.4	12.0	3.1—4.6
Uganda	0.8	0.9	1.2— 1.4	2.4	3.4—5.0
Total	250.3	309.0	404 — 445	5.3	3.0—4.1
World Total (Excluding Mainland China & the U.S.S.R.	718.1	824.3	965—1,029	3.0	1.8—2.5

TABLE 4.

PER CAPITA CONSUMPTION OF TEA AND COFFEE
IN THE UNITED KINGDOM 1950—65 (lbs. per head)

Year	1950	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65
Tea	8.3	8.2	8.6	9.5	10.0	3.1	10.1	9.8	9.9	9.7	9.3	9.9	9.4	9.3	9.2	9.0
Coffee	2.0	2.0	2.0	1.0	1.0	1.3	1.5	1.6	1.7	1.9	2.1	2.1	2.7	2.8	2.6	

Sources: CL - Tropical Products Quarterly
ITC - Annual Bulletin of Statistics

TABLE 5.

ANALYSIS OF LABOUR USE ON TWENTY ESTATES

Item	Labour days as % of Total	Labour days per acre
Plucking	44.4	127.6
Weeding	18.7	53.7
Forking and Manuring	4.3	12.3
Dusting and Spraying	3.6	10.3
Bush Sanitation	3.1	8.9
Green Manure	2.4	6.9
Pruning	1.9	5.5
Maintenance	6.4	18.3
Total for field work	84.8	243.3
Factory	8.5	24.4
Services	6.7	19.3
	100.0	287.0

Source : An investigation carried out using mailed questionnaires to Tea Plantation Superintendents in Ceylon by the author.
The analysis include all Labour, other than supervising and Office Staff. Maintenance including all work an roads, pallis, drains, terracing, Ravines and boundaries.
Bush sanitation includes work on mossing and ferning and root growth.
Factory – includes picking of stalk.

TABLE 6.

ANALYSIS OF THE COST OF PRODUCTION COMPUTED ON TWENTY ESTATES

Item	Cost per lb. in cents
1. General Charges	38.65
2. Cultivation Charges	
a. Weed control	17.22
b. Fertilizer cost	17.20
c. Other cultivation work (Crop protection, Soil conservation, Green manure) etc.	11.17
	45.59
3. Plucking	39.11
4. Manufacture	24.87
Total cost of manufacture per lb. of made Tea	148.22

Source : An investigation carried out, using mailed questionnaires to Tea Plantation Superintendents in Ceylon by the author.

Note :
The average yield per acre was 800 lbs.
wage rate used was Rs. 2/50 per diem.

THE EFFECT OF SOME STORAGE TECHNIQUES ON INTERIOR EGG QUALITY

H. KARUNAJEEWA

ECONOMIC losses due to spoilage of stored eggs is a common occurrence in Ceylon. It was recently reported that the Marketing department had destroyed over 500,000 table eggs which were spoilt during storage. Such losses could only be prevented by the adoption of more effective storage procedures. One of the factors causing spoilage of eggs is a deterioration in interior quality due to a loss of carbon dioxide from the egg albumen. High environmental temperatures are known to hasten this process while low temperatures and oiling seem to retard the loss of carbon dioxide from the egg (Froning & Swanson, 1962).

Two experiments to study the effect of oiling, packaging and temperature on interior quality of table eggs during storage, were conducted at the Department of Agriculture, University of Ceylon, Peradeniya.

EXPERIMENTAL

In the first experiment 106 eggs were selected from those laid by 15-month old White Leghorn incrosses in deep litterpens. The eggs were collected at about 3.00 p.m. on 29.5.67. Six eggs were used to record the initial interior quality measurements, and the balance hundred eggs were randomly divided into five groups of twenty each. Each group was subjected to one of the following treatments :—

T_1 — The broad end of each egg was dipped in a beaker containing coconut oil in such a way that only half of the egg was immersed. The eggs were then placed in a cardboard egg-flat with their narrow ends pointing downwards, and stored at room temperature.

T_2 — The eggs were oiled in the same way as those in T_1 and stored in a refrigerator.

T_3 — The eggs were untreated and stored at room temperature. This served as the control group.

T_4 — The eggs were untreated and stored in a refrigerator.

T_5 — The untreated eggs were subdivided into four sub-groups of 5 each and each sub-group was packed into a polythene bag which was heat sealed. The polythene bags were then placed in the refrigerator.

The refrigerator was maintained at a temperature of 9° C and a relative humidity of 54%.

At intervals of 7 days, 5 eggs from each treatment group were used for determination of interior quality. The eggs were weighed individually, albumen and yolk heights were measured, and the Haugh Unit Scores were calculated.

In the second experiment, 68 eggs were selected from eggs laid by one year-old White Leghorn incrosses in deep litter pens. The eggs were collected at about 4.00 p. m. on 5.7.67. Eight eggs were used for initial interior quality measurements. The balance 60 eggs were randomly divided into three groups of twenty each. Each group was subjected to one of the following treatments:—

T_1 — This treatment was similar to T_1 of Experiment 1 with the exception that gingelly oil was used in place of coconut oil.

T_2 — The eggs were untreated and stored in a refrigerator.

T_3 — The eggs were untreated and stored at room temperature.

On the 4th, 7th, 10th, and 14th days of storage, five eggs from each treatment group were used for determination of interior quality as indicated under Experiment 1.

RESULTS AND DISCUSSION

TABLE 1.

The daytime temperatures and relative humidities in the laboratory during the experimental periods.

	Temperature °C				% Relative Humidity			
	Average		Range		Average		Range	
	A.M.	P.M.	A.M.	P.M.	A.M.	P.M.	A.M.	P.M.
Experiment 1	26.9	28.5	24-30	25-31	66.9	62.5	59-74	52-72
Experiment 2	26.2	27.2	25-29	26-28	66.3	64.1	62-71	59-70

TABLE 2.

The effect of storage methods on some egg quality factors as determined after 28 days of storage — Experiment 1.

Quality measurements	Treatments				
	T_1	T_2	T_3	T_4	T_5
Average Haugh Unit Score	73 . 5	82 . 3	24 . 8	78 . 3	83 . 6
U. S. D. A. Grade	AA	AA	C	AA	AA
Average Albumen height (mm)	5 . 4	6 . 7	1 . 7	6 . 1	6 . 8
Average Yolk height (mm)	16 . 3	18 . 9	9 . 3	18 . 8	18 . 2

TABLE 3.

The effect of storage methods on some egg quality factors as determined after 14 days of storage — Experiment 2.

Quality measurements	Treatment		
	T_1	T_2	T_3
Average Haugh Unit Score	70 . 4	74 . 1	44 . 8
U. S. D. A. Grade	A	AA	B
Average Albumen height (mm)	5 . 1	5 . 6	2 . 8
Average Yolk height (mm)	17 . 0	19 . 4	13 . 5

The data in Table 2 and 3 indicate that table eggs dipped either in coconut or gingelly oil (T_1) and stored at temperatures and humidities shown in Table 1 maintain a higher interior quality than the untreated eggs (T_3) stored under similar environmental conditions. Goodwin *et al.* (1962) also had observed that untreated eggs lost significantly more Haugh Units than oil-treated eggs. This suggests that both coconut and gingelly oils are effective in sealing the pores of the egg shell and thereby preventing a loss of carbon dioxide and moisture from the internal contents of the egg.

The untreated eggs stored in the refrigerator (T_4 in experiment 1 and T_2 in experiment 2) were superior in interior quality to those of the control groups (T_3) and those dipped in oil (T_1). The interior quality of eggs that were either dipped in coconut oil or sealed in polythene bags and stored in the refrigerator (T_2 and T_5 of experiment 1) was better than that of untreated eggs stored in the refrigerator. These results indicate that when table eggs are oiled or packed in polythene bags prior to refrigeration, the loss of carbon dioxide from the egg albumen is more efficiently retarded. This suggests that such eggs could be stored under refrigeration for a longer period of time than untreated eggs.

The results of these experiments also suggest that when refrigerator facilities are not available table eggs dipped in either coconut or gingelly oil can be stored for a period of at least 28 days without any appreciable loss of interior quality.

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CONTENTS OF PREVIOUS ISSUES OF THE JOURNAL OF THE NATIONAL AGRICULTURAL SOCIETY OF CEYLON.

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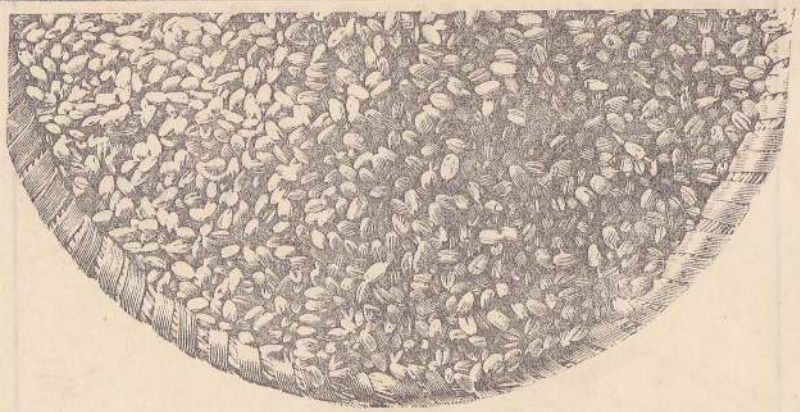

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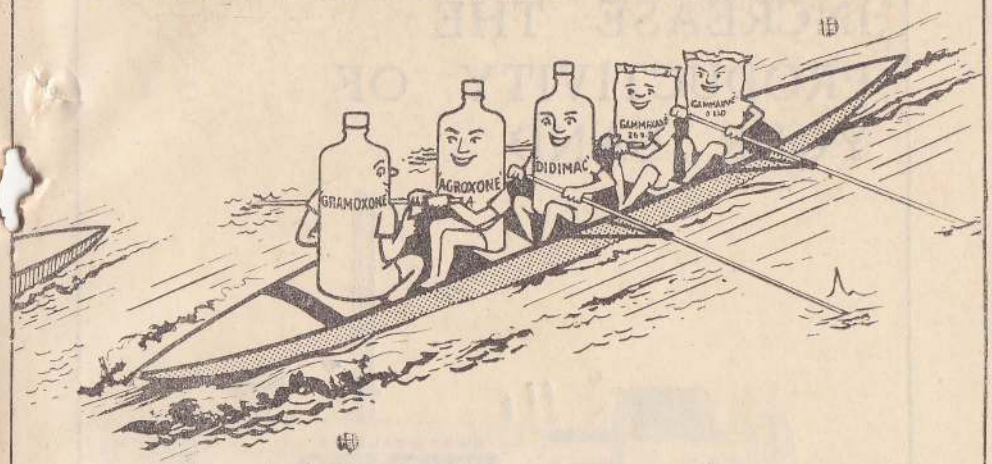

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