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INTERCROPPING OF COCONUTS WITH SPECIAL REFERENCE TO FOOD PRODUCTION*

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Introduction

Intercropping coconut lands has been a subject of some vigorous discussion among the planters of Ceylon for some time now. Intercropping is an age old practice. Catch cropping among coconut seedlings up to about the fourth year and later under mature stands is in practice here in Ceylon and elsewhere in the world. Considerable number of these reports are very encouraging while others are less so. Due to the heavy drain on foreign exchange for the importation of dairy products and other subsidiary food stuffs, successive governments during the past decade have without exception considered the possibilities of utilizing the 1.1 million acres of coconut lands for the purpose of producing these food requirements.

The Coconut Research Institute has created a Division of Agrostology with a view to studying the principles involved in intercropping particularly pastures and evolving a system of management for the successful production of coconuts and dairy products. This Division started in 1955 has carried out some preliminary studies and considerable amount of work is in progress. We have very recently included into our programme studies with other crops also.

Most crops can be interplanted with coconuts, but economic success depends on understanding the effect of the intercrop on the coconut and vice versa. In other words understanding the phenomenon of plant competition. The intercrop would compete with the coconut for soil moisture and plant nutrients if any one of them is in supply below the combined demand of the two crops. When such plant competition is operative, it would imply that the intercrop is utilizing the environmental factors that would have been otherwise available to the coconuts. This would then result in the loss of yield of coconuts.

* A paper read at the seminar on 'Tea and Coconut Industries' held at CISIR Auditorium on 16th Feb., 1966. This Seminar was organized by the Low Country Products Association.

Maize growing under Coconut

Soil Moisture Competition

Considering soil moisture competition first, in two experiments at Lunuwila it has been shown that when the two crops were adequately manured there was no loss of yield of coconuts due to the presence of pasture. In another experiment where soil moisture below pastures and weeds were measured, there was no difference in the pattern of soil moisture exhaustion.

This is a very important finding of wide applicability, i.e., it permits us to conclude that in all areas where the rainfall is similar to that at Lunuwila there would be no competition for soil moisture when a pasture is grown under coconuts. Lunuwila is just outside the Northern boundary of the Wet Zone of Ceylon and receives an annual rainfall of 75 ins. from both the S-W and N-E monssons. We may then conclude that in the Wet Zone a pasture will not adversely affect the yield of coconuts due to soil moisture competition. (Map). Pasture is a permanent crop. It may not be unreasonable to suggest that other permanent or semi-permanent crops such as cocoa, coffee, plantain, manioc, pineapple, etc. would also grow with coconuts without causing competition for soil moisture.

Further experimentation in areas with lower rainfall is necessary to determine the critical rainfall below which soil moisture competition would be operative inspite of liberal manuring of the two crops.

Within the Intermediate Zone it is highly unlikely that there would be any competition for soil moisture during the months April to June (S-W monsoon) and again from October to December (N-E monsoon). It is therefore possible for short term crops that grow and mature during these months to be grown without causing competition for soil moisture. Such crops are cereals, pulses and condiments. Some of these could be grown during the N-E monsoon only, while others could be grown during both monsoons. In this respect the recent publications of Seneviratne and Appadurai on "Field Crops of Ceylon" and Agricola on "A hand book

for the Ceylon farmer" are of great value. Success with these short term crops would depend on the selection of the right variety whose growth period fits in with the rainfall season of the locality. If the variety planted takes longer than the length of the season it will be completely dried up and there will be no yield to harvest. If on the other hand the variety matures before the end of the rains the produce will be damaged.

This is illustrated for Palugaswewa estate, situated near the Northern boundary of the Intermediate Zone, where the probability of receiving one inch of rain for each week separately has been computed. (Fig. 1).

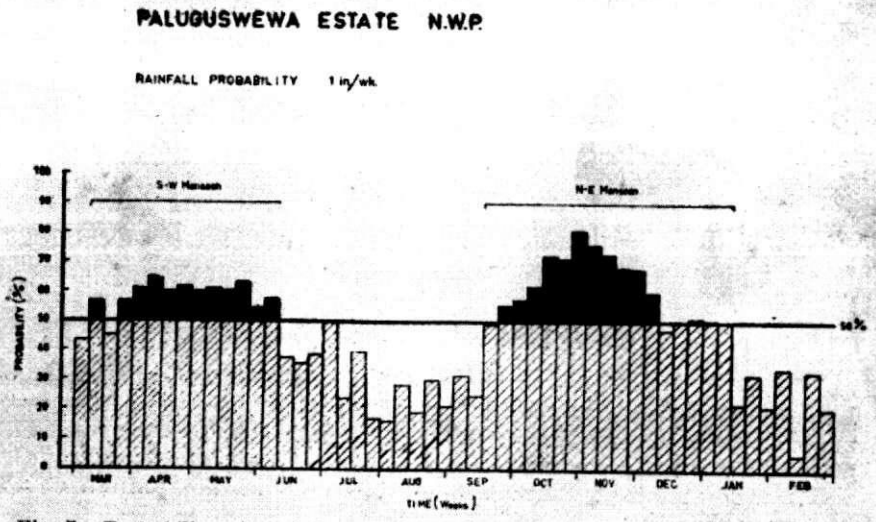

Fig. I. Probability of receiving 1 inch of rain per week at Palugaswewa Estate.

Using the 50% probability (tentative) as the critical value, it would appear that the S-W season commences during the last week of March and continues to the first week in June, with an effective length of season of 11 weeks. Similarly the N-E season commences during the last week of September and continues to the second week of January with a length of 15 weeks. A further consideration in the selection of the crop would be the soil type of the locality.

In the Dry Zone where effective and reliable rainfall is received only during the N-E monsoon intercropping with short term crops is possible only during that season.

Thus as far as soil moisture competition is concerned the coconut growing areas could be intercropped according to the rainfall pattern.

Zone	*Dry periods*	*Crop*
Wet	Nil	Permanent
Intermediate	Feb. and July-Aug.	Short term crops during S-W and N-E
Dry	Feb.-August	Short term crops during N-E only

The rainfall probability curves typical of the three Zones are shown in Fig. II. Further details of crops for each Zone are given in the Appendix.

The growing of trees such as mangoes, Cadju, Citrus, etc. in the Intermediate and Dry Zones is not commented on as no information is available in their water utilization pattern, particularly subsoil water, in relation to coconuts.

Nutrient Competition

Next important factor for which intercrops would compete with coconuts is plant nutrients such as nitrogen, phosphorus, potassium, etc. When no additional fertilizer was applied to the fodder (Napier grass) the yield of coconuts was reduced from 1173 lbs./ac./year copra to 619 lb. at Lunuwila. But with adequate manuring for the fodder grass the yield of the coconuts was restored to the original level.

Nearly all coconut soils are deficient in N, P and K. This has been accentuated by the particular method of circular trench manuring adopted in coconut estates. Whatever the type of intercrop that may be grown, adequate manuring with at least a mixture of N, P and K is *sine qua non* for the proper growth of the intercrop and elimination of nutrient competition.

Competition would be particularly severe for nitrogen and potassium. In the absence of N and K a pasture of *B. miliiformis* reduced the yield of coconuts by 14% in each instance. Both nitrogenous and potassic fertilizers are expensive and any methods evolved to reduce the amount of these two fertilizers required would add to the efficiency of intercropping and increase the profits to be derived from it. In this respect it is pertinent to point out that in intercropping maximum use should be made of the group of leguminous plants that fix nitrogen. Such crops are green gram, black gram, cowpea, ground nut, sun hemp, pasture legumes, etc. If the right strain of the nodule bacterium is provided, these plants could even be expected to add nitrogen to the soil.

Paddygrowing under Coconut

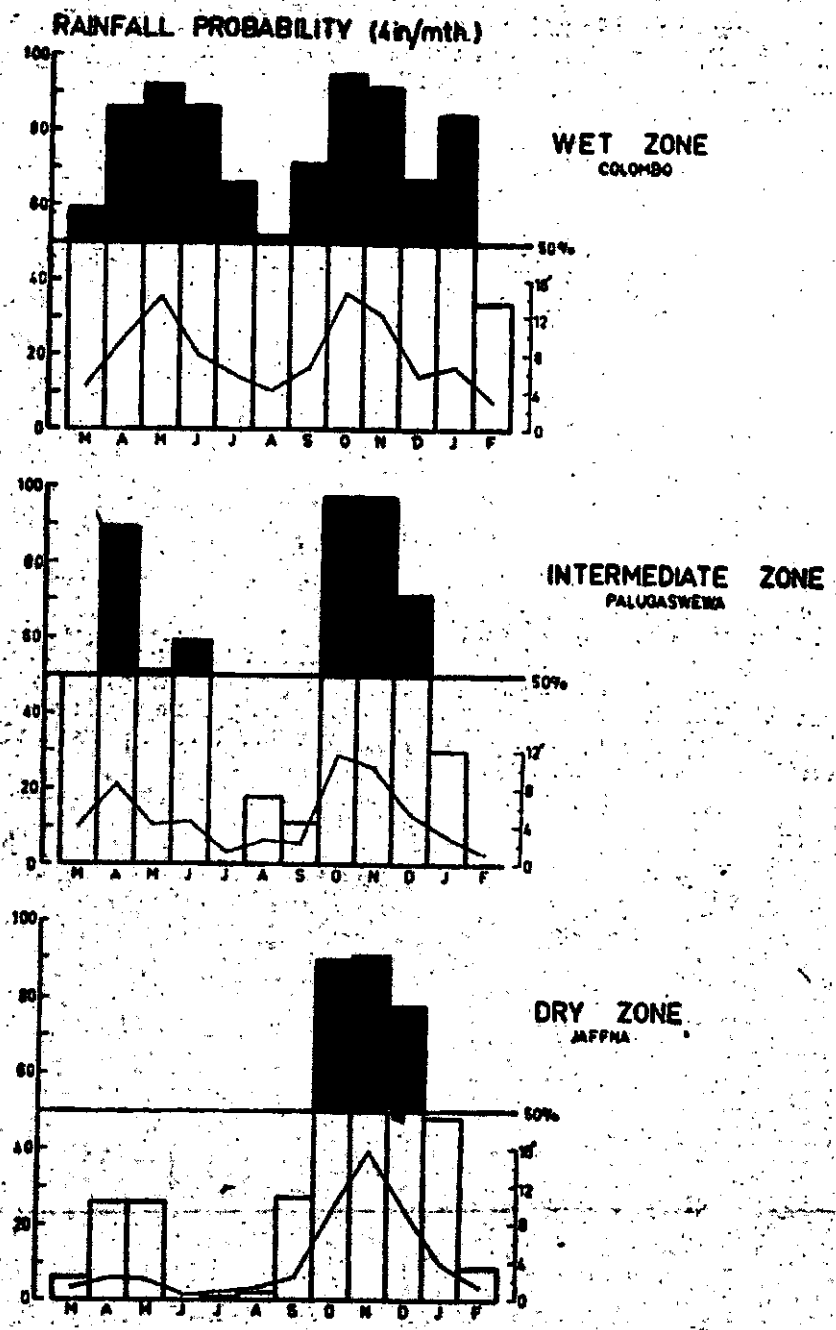

Fig. II. Rainfall probability curves for the three zones.

Proper manuring depends on two factors: on providing the nutrients in short supply and on the method of application. At Lunuwila in one experiment when the palms were manured round the base with 10 lbs. of a 3:3:3 mixture of sulphate of ammonia, saphos phosphate and muriate

of potash every two years and the pasture broadcast with 2 cwt. S. A. and 1 cwt. M.P./ac./year all competitive effects of the pasture for these nutrients were eliminated. The total amount of sulphate of ammonia applied per acre per year in this experiment amounted to 320 lbs. In another experiment even when 448 lbs. was applied broadcast there was still 5 and 13% reduction in yield of coconuts due to *B. miliiformis* and *B. brizantha* pasture respectively competing for nitrogen. It would then appear that placing a certain amount of the fertilizer round the base of the palms and broadcasting the rest would eliminate competition resulting in proper growth of both crops. The efficiency of placement of fertilizer to eliminate competition could be explained on the basis that in the restricted area round the base of the palms the amount of the roots of the pasture plants that would absorb the fertilizer is greatly reduced.

Tentatively it is recommended that coconuts should be manured at least once a year with the mixture recommended by the C.R.I., in a circle round the base of the palms, and the pasture manured broadcast at the beginning of each monsoon with a mixture of 1 cwt. S.A., ½ cwt. M.P. and ½ cwt. S.P. per acre. In the case of the short term crops the manurial recommendations in the two publications already referred to may be consulted with advantage.

Chillies growing under Coconut

The efficiency of fertilizer placement is best demonstrated where the intercrop could be identified as individual plants such as coffee, cocoa, plantain, etc. In the case of these crops further efficiency could be attained by adopting planting patterns.

We may then conclude the above discussion by stating that competition for soil moisture could be eliminated by the choice of crop for the various rainfall zones. Nutrient competition can be eliminated by proper manuring. Many of the failures of intercropping and loss of yield of coconuts has been mainly due to faulty choice of intercrop and complete lack of manuring.

Effect of Coconut on Intercrop

The main effect of the coconut on the intercrop would be the reduction of light available for their growth. The results of an experiment where plants were grown on either side of a translucent screen erected N-S and thus exposed to shade during different times of the day are recorded in Table 1. The greatest reduction was recorded with plants shaded for 2 hrs. around noon. During this period however the shadow cast by coconuts is at a minimum and occupy the area around the palms while the rest of the area is exposed to direct sunlight.

TABLE 1

Shade	*D.M. yield (gm./plant)*
Sun rise — 8 a.m.	7.75
Sun rise — 10 a.m.	7.47
Sun rise — Noon	7.22
Noon — Sun set	6.99
2 p.m. — Sun set	8.21
4 p.m. — Sun set	8.73

Dry matter yield (gm./plant) of *Phaseolus lathyroides* shaded at different times of the day.

Another factor of importance is the distribution of soil moisture within a coconut square during the dry months. The availability of soil moisture for the intercrop would be reflected in the moisture content of the plants. During August 1965 we sampled plants of Guinea grass planted in 1 ft. square under coconuts. The results are shown in Fig. III. It will be noticed that the percentage of moisture in the plants increased with their distances from the coconut palms reaching a maximum in the centre of the square. These two effects would result in reduction and variation in the yield of the intercrop which are however inherent. It is suggested that satisfactory growth of intercrop could be obtained under new plantings up to about the fourth year and again about 30 years onwards in stands about 24 ft. apart or more. The moisture effect would not be apparent during the rainy seasons.

Pasture Production

It is now necessary to consider some aspects of pasture production. In the first instance there should be suitable species of grasses and legumes that would produce good quantity and quality of feed. We have at the moment only two species of grasses suitable for pasture development

Pineapples planted in rows under Coconut

in the low country. These two species belong to the genus *Brachiaria*. They are all mat forming types, a character suitable for the high rainfall areas, where they would effectively check soil erosion and prevent weed growth, compared to clump forming types. Considerable amount of work is in progress at the C.R.I. on the management of *B. brizantha* and *B. miliiformis* pastures. We have found *B. miliiformis* to be somewhat superior to *B. brizantha* in the following considerations:—

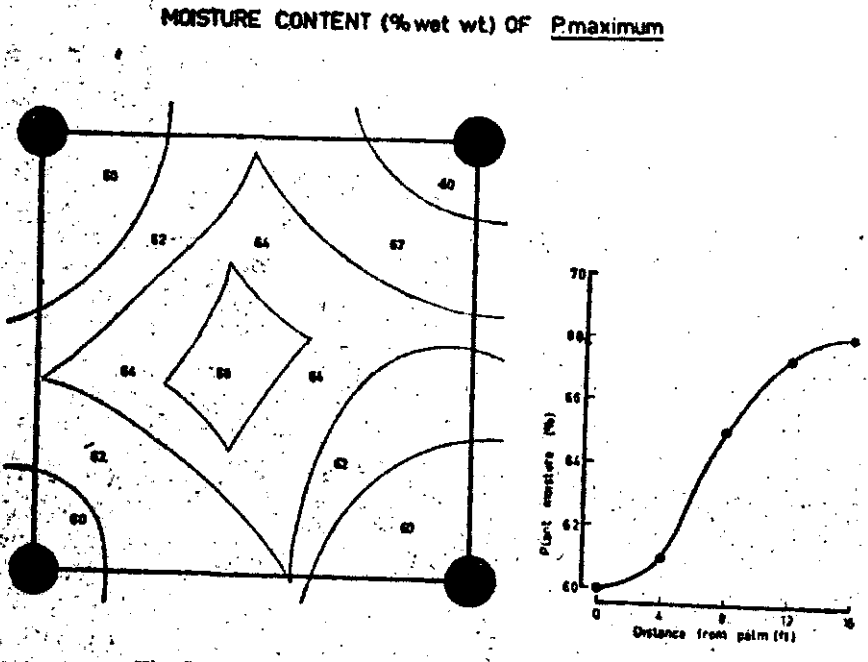

Fig. III. Soil moisture pattern within a coconut square.

1. *B. miliiformis* is cheaper and easier to establish than *B. brizantha*.
2. *B. miliiformis* withstands grazing and drought as well as or even better than *B. brizantha*.
3. *B. miliiformis* is more tolerant of shade than *B. brizantha* (Table 2). This is of particular advantage under coconuts.

TABLE 2

	25% *day light*		100% *day light*	
	N_0	N_4	N_0	N_4
B.m. ..	26.9	16.3	287.0	405.7
B.b. ..	7.7	2.2	178.5	160.8

Dry matter yield (gm./m²) of *B. miliiformis* and *B. brizantha* at two levels of nitrogen and light intensity.

4. *B. miliiformis* produces similar amounts if not more feed than *B. brizantha* under similar conditions (Table 3). The former dominates the latter in association.

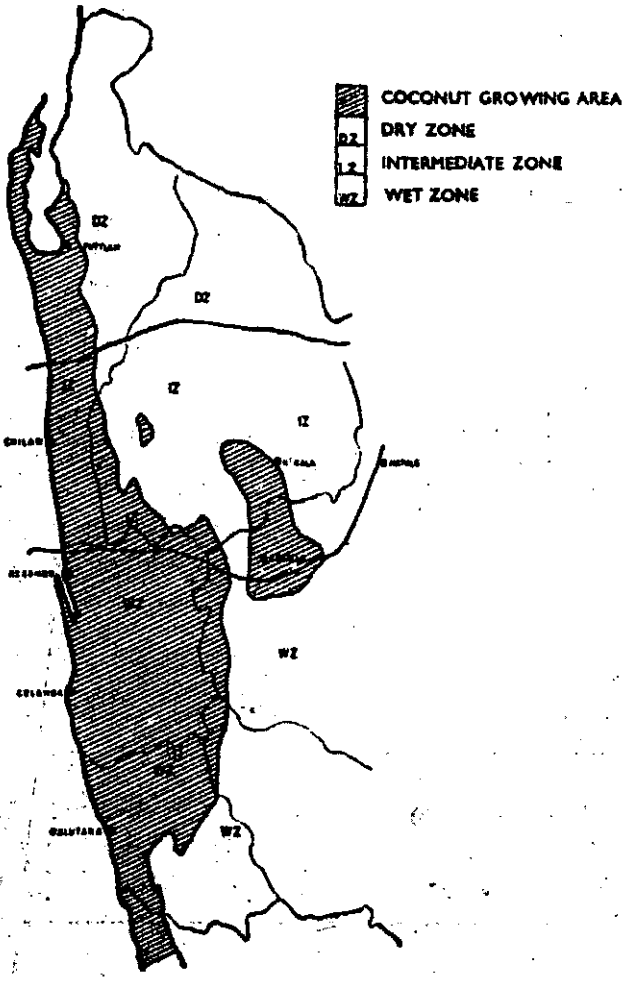
COCONUT GROWING AREA
DRY ZONE
INTERMEDIATE ZONE
WET ZONE
DZ
IZ
WZ

TABLE 3

	N_0	N_2	N_4
B.m. alone	138.7	226.7	243.7
B.b. alone	131.7	179.0	136.0
B.m. in mixture	87.7	139.0	200.0
B.b. in mixture	84.7	85.3	32.3

D.M. (gm./m²) of *B. miliiformis* and *B. brizantha* grown alone and in mixture at three levels of nitrogen.

5. *B. miliiformis* is less competitive with coconut compared to *B. brizantha* (Fig. IV).

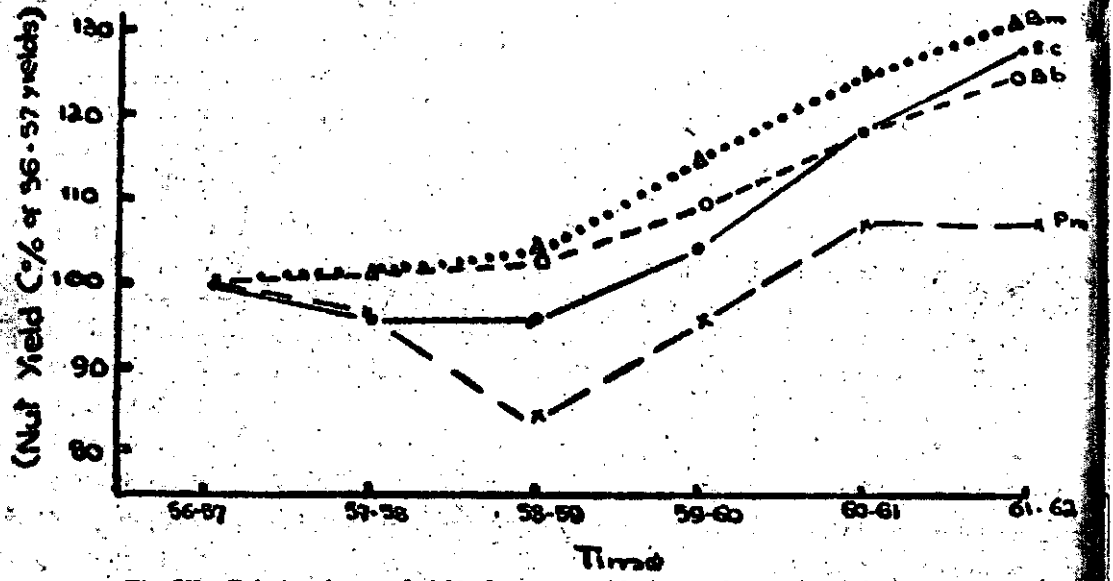

Fig. IV. Relative change of yield of coconuts with time under wood and three grasses.

From the point of view of the quality of feed and nitrogen regime of the complex association of coconuts, pasture and animal, incorporation of an effectively nodulating legume with the pasture is necessary. The selection of a suitable legume and its associated strain of *Rhizobium* is receiving the attention of pasture ecologists in all tropical countries. Of the three legumes available, the perennial forms, namely, *Pueraria* and *Centrosema* appear to be more satisfactory than the annual *Calopogonium* from the point of view of persistency and nitrogen fixation. There is some evidence to show that *Centrosema* would be successful in heavier and *Pueraria* in lighter soils. Level of nitrogen application and intensity and frequency of defoliation would also affect their yield and persistency. Recent reports show that cattle do not accept *Pueraria* readily. Animals fed grass and *Pueraria* did not perform as well as those receiving grass only from the point of view of milk yield. The search for better species of grasses and legumes and their associated strains of *Rhizobium* is in progress at the C.R.I.

Regarding fodder grasses *Panicum maximum* (Guinea grass) is very satisfactory. Here too strains from other countries are being studied.

The next important factor in pasture production is the efficiency of the grazing animal is converting this pasture into milk and or meat. An efficient animal may be characterised as one that eats least (small size) and yields most. A convenient index of efficiency may be calculated by dividing the yield per lactation in gallons by the body weight in lbs. The locally available Sinhala and Scindhi have very low indices compared to the well established European breeds. (Table 4).

Table 4

Breed	*Ratio of Yield/Body wt.*
Sinhala	0.25
Scindhi	0.40
European in England ..	0.75 (mean of 3)
European in Ceylon ..	0.58 (mean of 3)
Sinhala × Freisian	0.66
Sinhala × Ayr.	0.68
Sinhala × Jer.	0.70

Ratio of milk yield (gal/lact.) to Body weight (lb./head) of some breeds of dairy cattle.

The latter breeds however do not perform satisfactorily in Ceylon. Their crosses with the local sinhala are very promising. Among them the Sinhala × Jersey cows is to be much desired from the point of view of adaptability, small size, high yield and richness of milk. This animal will be suitable to the small holder as well as estate owners. In this respect the efforts of the Department of Agriculture is to be highly commended.

Conclusion

With the selection of the right type of crop for the various rainfall belts and soil types and adequate manuring, coconut lands can be intercropped successfully. Allowing for under and replanting and immature stands up to 30 years or so, the potential land available for intercropping may roughly be about 200,000 acres in the wet zone and 100,000 acres in the Dry Zone. It is hoped that even if a small portion of this acreage is intercropped, Ceylon would be able to reduce the importation of milk, meat and other subsidiary food stuffs to some degree.

Appendix

Recommended intercrops for the various Zones.

A. Wet Zone

No marked dry period. Permanent crops.

Crops	*Variety*
Pasture ..	B.miliiformis (Sinh. × Jer.)
Fodder ..	P. maximim (Sinh. × Jer.)
Coffee ..	As per D.A.*
Cocoa ..	,,
Plantain ..	,,
Pineapple ..	,,
Manioc ..	,,
Paddy ..	Highland as per D.A.*

B. Intermediate Zone

Marked dry period during February-March and again from July-September. Short term crops.

1. S-W monsoon (Late March-Mid June)

Crop	*Variety*
Cowpea ..	M.I. I
Green gram ..	M.I. I
Black gram ..	M.I. I
Ground nut ..	Vauniyaya local
Gingelly ..	M.I. S
Paddy ..	As per D.A.*
Sorghum ..	As per D.A.*
Maize ..	T 48
Manioc ..	As per D.A.*

All varieties should be less than 90 days duration and planting should be complete by the first week in April.

2. N.E. monsoon (Late September-Mid January)

All crops under 1. either with longer duration varieties or same planted about 3rd week in October.

Crop	*Variety*
Ground nut ..	As per D.A.*
Manioc ..	As per D.A.*
Chillies ..	As per D.A.*

These three crops are 3½ — 4 months duration and should be planted with the opening rains in late September or early October.

C. Dry Zone

Marked dry period from February to September. Crops recommended under B.2. are suitable.

*D.A. = Department of Agriculture. For necessary instructions please write to Agricultural Officer, Extension Aids Division, Saunders Place, Colombo.