INTERCROPPING UNDER COCONUTS IN SRI LANKA*

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ABSTRACT

Coconut is a major commercial crop of Sri Lanka. Growing a number of other crops in association with coconuts is a widespread practice in all coconut-growing areas of the country. The rationale for the practice is that other crops can profitably be grown between or under the coconuts during the different growth stages of the palms and thus the overall productivity of the land under this long-duration crop can substantially be increased.

The paper gives a concise account of the practice in Sri Lanka indicating the crops most commonly grown as intercrops, arrangement of different crops and early research results on the productivity of the intercrops and their effect on coconuts. Adequate supplies of water and labour are the two major inputs needed for the success of the system. Drought, lack of funds, price instability, lack of technical know-how on intercrop management and problems of timely availability of inputs are the major constraints experienced by farmers in expanding intercropping. Research on both biological and socio-economic aspects is needed to overcome these constraints and extend this potentially attractive system.

Key words: Agroforestry, Coconut, Intercropping, Sri Lanka

1. INTRODUCTION

Coconut (*Cocos nucifera* L.) is cultivated in about 400,000 ha or 25 percent of the total cultivated area of Sri Lanka. It is the most widely cultivated plantation crop of the island nation, the other major two being tea (244,916 ha) and rubber (222,311 ha), and is thus second only to rice (874,221 ha) in terms of the area under the crop. Although coconut is grown in all the districts of Sri Lanka, about 70 percent of the area under the crop is concentrated in the "COCONUT TRIANGE" formed by the districts of Kurunegala, Puttalam, Gampaha and Colombo in the central west coast (Fig. 1). Other important coconut areas include the districts of Kalutara, Galle, Matara and Hambantota accounting for about 15 percent of the total area. The rest of the area is found mostly in the small home gardens in other districts.

FIGURE 1

It is a wide-spread practice in all coconut growing areas of Sri Lanka to grow a large number of other crops in association with coconuts. The practice has been encouraged by the Government of Sri Lanka since 1973 by introducing several subsidy schemes. This paper examines the situation with respect of coconut intercropping in Sri Lanka and summarizes the results obtained so far. Cattle grazing on pasture grown under coconuts is also a common practice in some parts of the country (4), but this paper does not cover that system in detail.

2. GENERAL DESCRIPTION OF THE AREA

2.1. Biophysical Environment

Sri Lanka is a tropical island located between 5^{o} 55' and 9^{o} 51' N latitudes and 79^{o} 42' and 81^{o} 53' E longitudes. The total area is 65,610 km^2, extending to a maximum of 410 km in N-S direction and 225 km

in E-W direction. There are different forms of tropical climates within the country depending on rainfall, temperature and altitude (topography). There are four major rainfall zones (13):

- the West Zone that has more than 500 mm rain per month during May to September (southwest monsoon), with a mean annual rainfall of 2500 mm or over;
- the Intermediate Zone, which is a part of the Wet Zone, with a mean annual rainfall of 1875-2500 mm;
- the Dry Zone with less than 500 mm of rain per month during the southwest monsoon season of May to September and a total annual rainfall of 1250-1875 mm;
- the Arid Zone, which is a part of the Dry Zone with a mean annual rainfall of less than 1250 mm.

In Sri Lanka, coconut is grown most prominently in the low country Wet and Intermediate rainfall Zones as indicated in Fig. 1. It is also grown to some extent in the Dry Zone wherever facilities for irrigation exist. In view of the changing distribution pattern of rainfall followed by unprecedented drought periods, a considerable attention has now been focussed on the subject of supplementary irrigation of coconut plantations during droughts, especially in the Intermediate and Dry Zones. On the basis of hydrogeology of the area and long term rainfall records, it has been estimated that available ground water potential ranges from around 2400 cu. m ha^{-1} per annum in the Wet Zone to 800 cu. m ha^{-1} in the Dry Zone, without affecting the water table (8).

Temperatures are generally around 27^{o} C with only a slight difference

in the diurnal and seasonal fluctuations. The relative humidity in coconut growing areas is also high with a mean of 85%. There is no marked difference in day lengths between seasons, which favours the cultivation of a wide variety of other crops in major coconut growing areas.

The major soil types found in the coconut belt are generally related to the nature of parent material, topography and agroclimate of the area. In the Wet Zone, for example, the dominant soil type in which coconut is grown is a shallow to moderately deep gravelly clay loam, passing to laterite at depth. In the Intermediate Zone, coconut groves are distributed mainly in the sandy clay loam type of soil passing to soft lateritic subsoil. In the Dry Zone, coconut plantations are either flat or undulating excepting a few low to moderately sloping lands. As such, the majority of coconut plantations in Sri Lanka occupy fertile lands of different agroclimate and soil environment suitable for intercropping with a wide range of crops.

2.2. Land Use Systems

With the exception of the area covered with montane rain forest and wet *patanas* (grass lands), rice cultivation is possible and popular in Sri Lanka in all places lying below 1200 m altitude and having irrigation facilities. Some parts of cultivated land in Sri Lanka, especially in the dry northern and eastern plains and to a lesser extent in the southwest, are under shifting cultivation *(chena)*.

Besides these two cultivated land systems, three big plantation systems are important for the island's economy: rubber, tea and coconut. Rubber plantations are in the wet low country up to an elevation of 700 m and tea up to an elevation of nearly 2300 m, tea

plantations being the only form of land use in areas above 1200 m. Coconut is very important in the internal economy and food system of the country. It used to be a major export crop in the past, but according to 1982 figures (7) about 70 percent of the total nut production was used for domestic consumption, leaving about 30% as the exportable surplus. Coconut therefore has a dual role to play, meeting the increasing local demand as well as continuing to serve the most vital export market. Cacao, cinnamon, cardamon, citronella and pepper as minor export/cash crops also contribute to the economy of Sri Lanka. Forests account for 24.9 percent of the area of the country (9).

Sri Lanka practices a number of agroforestry systems. The most prominent ones are 'chena', which is a form of shifting cultivation, some forms of taungya, intercropping under coconut, Kandy- or Home- or Forest Gardens, growing tea and coffee under the shade of trees and wind breaks/shelter belts (24).

3. STRUCTURE OF THE COCONUT INTERCROPPING SYSTEM

3.1. Components

The growth habit and morphology of the coconut palm permit a number of other crops to be grown with or under it during its different growth stages (18). A large number of compatible crops - both annuals and perennials - are grown under coconuts in different geographic and ecoclimatic regions (10, 12, 14, 15, 16, 18, 19, 21, 25). The major crops grown in association with coconuts in the different climatic zones of Sri Lanka are listed in Table 1.

TABLE 1

Sample surveys of intercropping under coconuts conducted recently

(1, 2, 3) in the Wet and Intermediate Wet Zones indicated that bananas, black pepper, coffee, ginger in that order formed the intercrops most preferred by the farmers. The second group in the order of preference consisted of turmeric, betel, vegetables and pineapple. Factors such as profitability, marketing facilities and convenience were listed as the major reasons for farmers' preference for the crops mentioned.

3.2. Arrangement of Components

The three planting systems recommended for coconuts (sole stands) in Sri Lanka are the square (7.9 x 7.9 m), rectangular (8.5 x 7.3 m) and triangular at 8.5 m equilateral, each system accommodating a density of about 160 palms per hectare (17). In the coastal belt, palm densities are relatively high, often up to 210 palms per hectare.

Based on the evaluation of the pattern of utilization of the basic resources -- soil and solar energy -- in monocrop coconut stands of varying age groups (18, 19), it is now generally accepted that coconut stands can conveniently be intercropped when they are either young (up to about eight years after planting) or fully grown and bearing (after about 25 years after planting). According to these considerations and in view of the age group of palms, it is estimated that 70-80 percent of coconut plantations in Sri Lanka can be intercropped (2, 22, 23).

The crop mixtures that are commonly associated with mature coconuts are as follows:

Coffee/banana

Banana mixed with either ginger/turmenic or pineapple

Pineapple/papaya

Banana/mixed with coffee/cacao

Coffee/black pepper

Cacao/coffee (dwarf San Roman variety)/black pepper

The arrangement of components depends on the nature of the intercrop. Generally speaking, a circular area of about 2 m radius around the palm is felt free of intercrops and the intercrops are grown in the inter-spaces of coconut rows according to the recommended planting system for the sole crop of the intercrop concerned. Fig. 2 indicates a schematic planting pattern involving black pepper, cacao and coffee with coconuts. Photographs of cassava and cacao + black pepper as intercrops with coconuts are given as Figures 3 and 4 respectively to show the planting arrangements of the components.

FIGURE 2

FIGURE 3

FIGURE 4

3.3. Interaction of Components

Theoretical considerations on plant community interactions in multi-species combinations with coconuts have been discussed by Nair (18) in the light of the limited research data that were available at that time. In practical terms, the main expectation from an intercropping system in a perennial plantation crop system is that the overall return from unit piece of land is increased without adversely affecting either the current or the long-term productivity of the main (perennial) crop. At the same time, the returns from the additional crops should justify the adoption of the intercropping practice and should contribute to the long-term productivity of the system. Thus, intercropping in coconut stands is viewed as a means for increasing the total productivity of lands that are "committed" to the coconut crop for up to, say, 70 years (which is the normal life-span of the 'Tall' type that forms the vast majority of coconuts grown all over the world).

Results of intercropping experiments conducted at the Coconut Research Institute (CRI) of Sri Lanka summarized in Table 2 indicate that intercropping resulted in an increase of nut yields of coconut. Similar reports are also available from intercropping trials in India (20, 21, 25). The explanation given for this beneficial interaction is that the palms are benefitted by the manures and fertilizers given to the intercrops, elimination of weeds, soil working and other management practices, etc.

TABLE 2

Some of the other obvious advantages of intercropping include better and more intensive utilization of land, more income and generation of more employment from land already planted with coconut, and income from cash crops.

It is also likely that there will be negative interaction leading to adverse effect on the main crop (coconut) and/or the intercrop. Such effects are likely to arise and be aggravated if the intercrops are not adequately and properly managed. However, practically no quantitative data are available from Sri Lanka on these aspects.

4. SYSTEM FUNCTIONING

4.1. Resource Input and Utilization

In Sri Lanka, coconut is generally grown under rainfed conditions. Experimental evidence shows that there would be no serious competition for soil moisture between coconuts and the intercrops if the annual rainfall is over 1900 mm. However, in the Intermediate (rainfall) Zone and the drought-prone Dry Zone, it will be risky to grow coconuts as well as long-duration intercrops with them if irrigation facilities are not available. The earlier-mentioned survey of intercropping (2)

revealed that irrigation facilities were available to 17 percent of the farmers who practised intercropping in the Intermediate Zone.

Labour is one of the other major resources needed for intercropping. A study conducted by the Agrarian Research and Training Institute, Colombo (6) revealed that intercropping in coconut stands resulted in a 300% increase in on-farm employment. Some basic farm management data collected over five years from the intercropping trials at the CRI are given in Table 3. It shows that depending on the type and number of intercrops involved, the requirement of labour and the share of labour cost in the total cost of production increased. While the timely availability of labour could pose a problem in some places, the generation of additional on-farm employment can be a very encouraging aspect in owner-cultivated smallholdings. However only a very small percentage of coconut holdings is owner-cultivated in Sri Lanka (see section 4.4.).

4.2. Production

Some data on the production from intercropping systems have already been presented (Tables 2 and 3). These are from experiments conducted at CRI. Although coconut intercropping is widely practised in all coconut growing areas of the country, quantitative data on production aspects from cultivators' fields have not been systematically collected.

4.3. Protective and Service Aspects

Monocrop stands of coconuts offer only partial coverage of the ground when the palms are young and also as they advance in age when the stems get elongated. Consequently the soil gets more exposed to erosion and degradation during these periods. Incidentally, these are the periods when intercropping is most feasible and desirable. In monocrop coconut

stands, it is a common management practice to adopt soil and water conservation practices such as terracing, preparation of bunds and contour drains and burying coconut husks in pits and trenches near the palms to conserve moisture (5). By practising intercropping and adopting prudent land management practices for the intercrops, much of these soil conservation practices which would otherwise be necessary, could be avoided. Thus intercropping can be a better way for increasing the sustainability of coconut lands.

4.4. Socio-Economic Aspects

In Sri Lanka, coconut holdings of less than 4 ha in size are considered smallholdings. The census of agriculture, 1982, which covered ten percent of coconut holdings in the districts Kurunegala, Gampaha, Colombo and Puttalam of the "coconut triangle" indicated that 55 percent of the total area of coconut in the coconut triangle are composed of such smallholdings (Table 4). There is a rather complex relationship between land ownership, owner cultivation/supervision and intercropping. The vast majority of coconut holdings in the country are not cultivated or supervised by the owners. The general pattern is that the majority of coconut farmers are also engaged in paddy rice (and other crops) cultivation in so much as that smallholders who cultivate their own land seldom practise intercropping because most of their time is utilized for growing rice and other crops (in non-coconut areas). On the other hand, holdings are leased, share-cropped or otherwise managed or supervised by non-owners are intercropped. Sixty-three percent of intercropped coconut holdings are thus cultivated/supervised by non-owners whereas only 26 percent of the non-owner cultivated/supervised holdings are non-intercropped.

TABLE 4

5. CONSTRAINTS AND POTENTIALS

5.1. Constraints

The sample survey of intercropping in coconut lands (2) has identified seven important problems/constraints that are faced by the farmers in expanding their intercropping activity. These, in the order of their relative importance, are: drought, lack of funds, price instability, lack of technical know-how, problems of timely availability of labour, availability of planting materials, and thefts. On an average, each intercropper faced at least three of these problems, their nature and extent being dependant on the size of the holding and type of intercrop. For example, lack of technical know-how and funds and non-availability of plant materials and fertilizers were more acute problems faced by smallholders, whereas droughts, price instability and thefts were reported as general problems affecting all categories of holding sizes.

In addition to the above, marketing of perishable seasonal crops (e.g., passion fruit, papaya, pineapple) and crops that are produced in bulk (e.g. ginger, turmeric) can also be a serious problem. It can be aggravated if intercropping extends to large areas without simultaneously developing processing facilities at the producing centres and/or transportation infrastructure to consuming/processing centres.

5.2. Potentials

Notwithstanding the above-mentioned constraints (which are not insurmountable), the system has a great scope for expansion in Sri Lanka and extrapolation to other areas. In principle, this is a sustainable system provided that necessary inputs are available in proper times and quantities, and the system is managed appropriately. At present,

intercropping practises are being extended to additional coconut areas at an annual rate of 1000 ha, thanks to the several Government subsidy schemes.

6. RESEARCH NEEDS

The constraints identified in the previous section call for research on both biological and socio-economic aspects, and the development of an efficient extension service in order to make coconut intercropping system more productive, economical, adoptable and successful. The agronomic requirements of individual crops when they are grown as intercrops need to be standardized. At the same time, the interaction of crops when they are grown in close proximity need to be studied elaborately so that research results can be obtained on the pattern of sharing of resources and growth factors by all component species of the system. In order to arrive at prudent management recommendations, it is necessary to take into account both complementary and competitive interactions affecting production of individual species as well as total production of the whole system, not only during a short span of time but over a long period on a sustainable basis. A reassessment of the hitherto accepted planting patterns and densities of sole crop coconuts is also worth undertaking with the objective of growing intercrops without adversely affecting the palm's productivity. While most other agroforestry systems consist of perennials that often help improve soil fertility through continuous addition of leaf litter and other organic materials, coconuts do not add much organic materials to the soil, and, therefore, ways of maintaining soil fertility in coconut intercropping systems through external application of nutrients have to be designed appropriately. Along with studies on these aspects of coconut intercropping system, research on various aspects on the

related system of pasture and grazing under coconuts also needs to be intensified.

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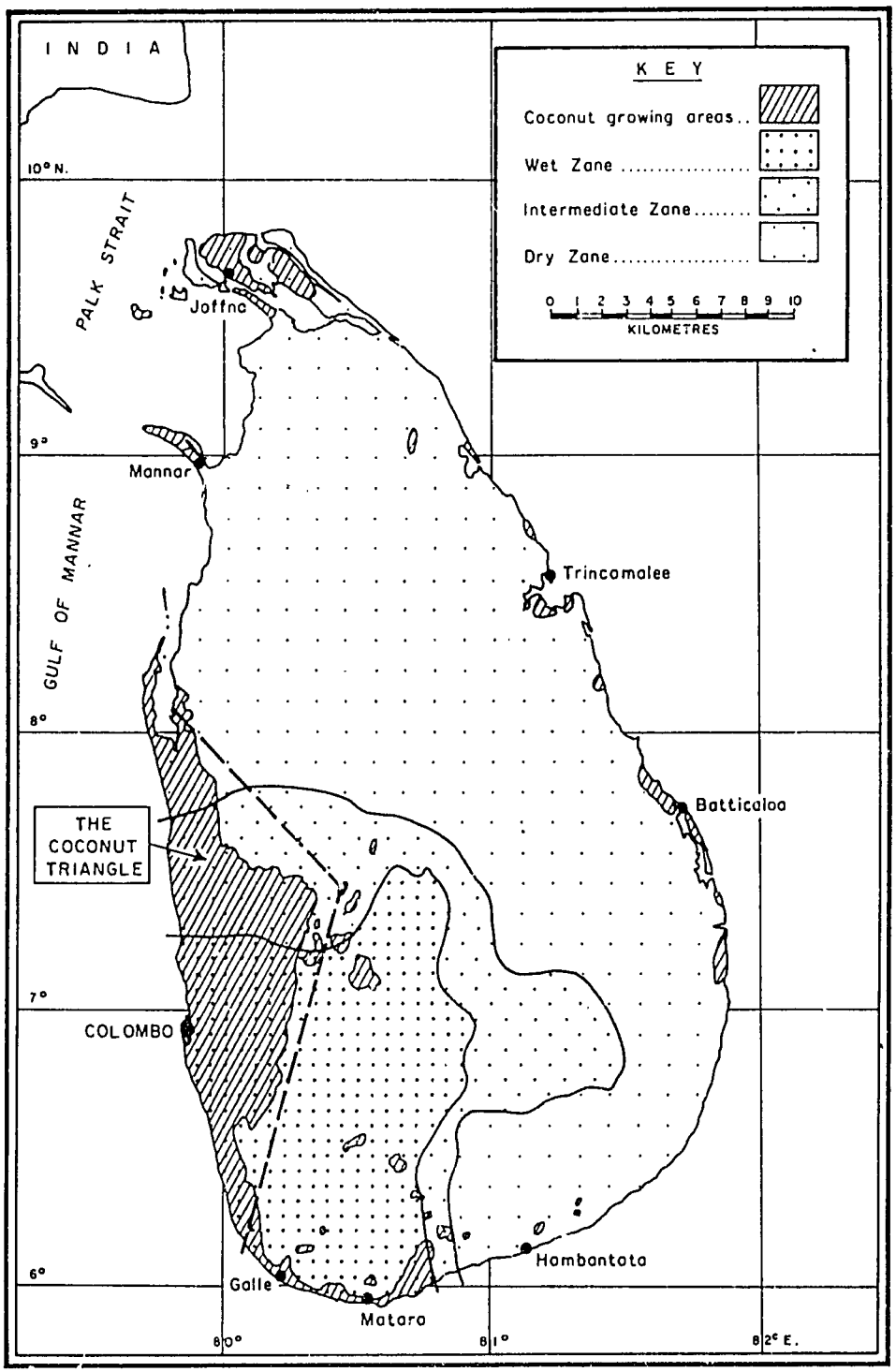

Fig. 1: Map of Sri Lanka showing the three major rainfall zones and the coconut-growing areas.

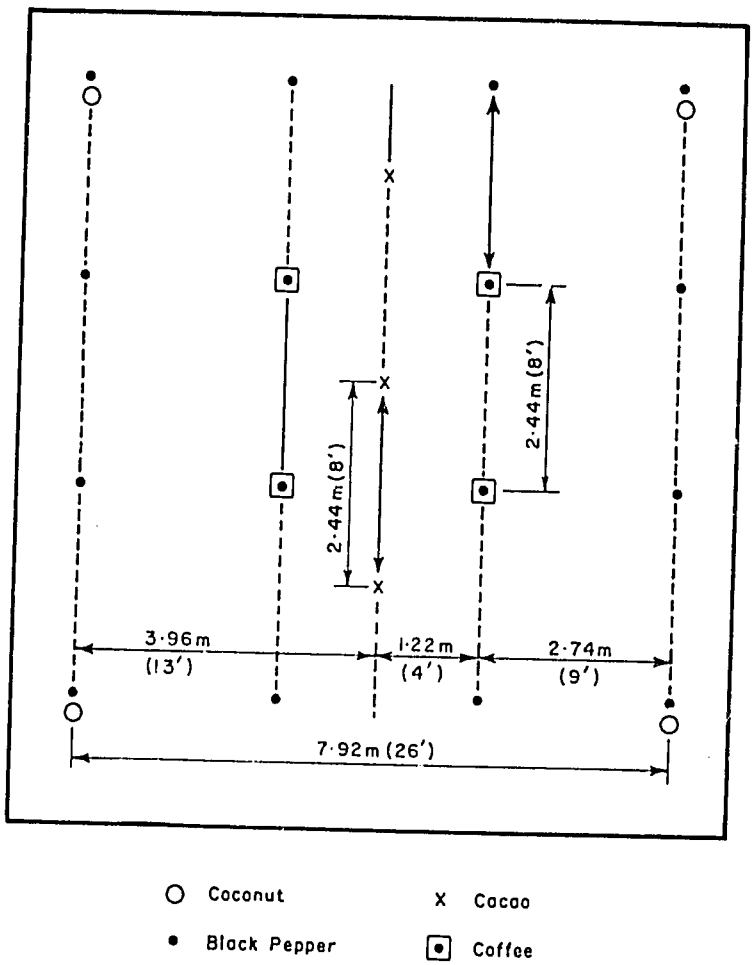

Fig. 2: Schematic patterns for planting black pepper, cacao and coffee as intercrops with coconuts, giving a plant density of 795 black pepper, 550 cacao and 640 coffee per hectare in addition to 159 coconut palms.

Table 2. Yield of coconuts when intercropped with different crops

Intercrops	*Yield of coconuts ha^{-1} yr^{-1}
Clove	5549
Black pepper	5466
Cacao	6738
Cinnamon	7080
Coffee	7318
Annuals in rotation	6825
Control (no intercrop)	5172

* Average of four years' (1978-1981) results at the Coconut Research Institute.

Table 3. * Some Basic Farm Management Data per Hectare on Intercrops Grown with 35-year-old Coconuts

Intercrop(s)	Inputs				Output		Net Income from intercrop	
		cost**						
	Labour (days)	Labour	Materials	Total	Yield (kg)	Value**	Annual	Cumulative
Coffee								
1st year	144	2520	1685	4205	-	-	- 4205	- 4205
2nd year	77	1348	1380	2728	-	-	- 2728	- 6933
3rd year	89	1558	1725	3283	50	2000	- 1283	- 8216
4th year	112	1960	1625	3235	225	9000	5765	- 1036
TOTAL	514	8996	8040	17036	400	16000		- 1036
Cacao								
1st year	144	2511	1910	4421	-	-	- 4421	- 4421
2nd year	75	1308	1405	2713	-	-	- 2713	- 7134
3rd year	63	1099	1725	2824	65	1625	- 1199	- 8333
4th year	48	837	1625	2462	227	5688	3226	- 5107
5th year	60	1046	1625	2671	525	13125	10454	5347
TOTAL	390	6801	8290	15091	817	20438		5347
Cacao, Coffee and Black pepper								
4th year	209	3662	3200	6862			16972	

* Based on five years data at CRI, Sri Lanka.

** Value in Sri Lanka Rupees; 1 US $ = SL Rs 25 (approx., 1984).

Table 4. Size - class distribution of coconut holdings in the coconut triangle of Sri Lanka

Size, class, category	Hectarage	Percentage
< 0.40 ha	22,996	8.49
0.40 - 2.0 ha	87,907	32.47
2 - 4 ha	38,202	14.11
4 - 8 ha	27,304	10.09
> 8 ha	94,343	34.84

Source: Census of Agriculture, Sri Lanka 1982.

Table 1. Intercrops Grown under Coconuts in Sri Lanka

Type of Crops	Crops		Wet Zone	Intermediate Wet Zone	Intermediate Dry Zone
1. Food Crops					
Tubers	Cassava	*Manihot esculenta*	x	x	
	Sweet potato	*Ipomoea batatas*	x	x	
	Taro	*Colocasia* spp.	x	x	
	Yams	*Dioscorea* spp.	x	x	
Cereals	Finger millet	*Eleusine coracana*			x
	Maize	*Zea mays*		x	
	Sorghum	*Sorghum bicolor*		x	
Legumes	Cowpea	*Vigna unguiculata*		x	x
	Green gram	*Vigna radiata*		x	x
	Groundnut	*Arachis hypogaea*		x	x
	Soybean	*Glycine max*		x	
	Winged bean	*Psophocarpus tetragonolobus*	x	x	
Fruit crops	Banana	*Musa* spp.	x	x	x
	Citrus	*Citrus* spp.		x	x
	Papaya	*Carica papaya*		x	
	Passion fruit	*Passiflora edulis*	x	x	
	Pineapple	*Ananas comosus*	x	x	
	Pomegranate	*Punica granatum*			x
2. Spices and Condiments	Arecanut	*Areca catechu*	x	x	
	Betel leaves	*Piper betel*	x	x	
	Chillies	*Capsicum* spp.	x	x	x
	Ginger	*Zingiber officinale*	x	x	
	Turmeric	*Curcuma longa*	x	x	
3. Miner Export (Cash) Crops	Black pepper	*Piper nigrum*	x	x	
	Cacao	*Theobroma cacao*	x	x	
	Cinnamon	*Cinnamon zeylanicum*	x	x	
	Clove	*Syzygium aromaticum*	x	x	
	Coffee	*Coffea* spp.	x	x	
	Nutmeg	*Myristica fragnas*	x	x	
4. Others	*Pasture grass	*Brachiaria miliiformis*	x		
	Sesame (oil seed)	*Sesamum indicum*			x

* Also see Nair (19)