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Integration of animal production and other crops into the coconut cropping systems in Sri Lanka*

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INTRODUCTION

Of the three plantation crops in Sri Lanka coconut affords the greatest opportunity for intercropping and mixed cropping. The potential advantages of cropping systems involving two or more crops have been long recognized. This has particular relevance in areas where arable land is in short supply and maximum land utilization appears to be the only way of achieving self-sufficiency in agricultural products.

One of the most promising modifications of a farming system already in existence in Sri Lanka is the utilization of the space between coconut palms for pasture production and cattle rearing. This is not a new concept. Cattle have been an integral part of the coconut farming system for a very long time. However under that system cattle have been used mainly as mowing machines to keep down weeds and also for purpose of obtaining manure. Animals in excess of that requirement were generally sold to the butcher and this accounted for a substantial portion of the beef consumed locally. What is new is that coconut land owners are encouraged to grow improved pasture species and legumes, to apply fertilizers, thereby increasing stock carrying capacity and to adopt management techniques designed to give maximum pasture utilization under this system of intensified farming.

Most coconut small holdings (homestead gardens) in Sri Lanka are mixed cropped with ornamental plants, fruit trees, vegetable plants, spices and occasionally pastures. In most instances this is a very uneconomic system of land utilization as there is a very severe competition between the component plants in this system where plants are overcrowded. However in areas in and around Matale a highly successful system of intercropping coconut with coffee, cocoa, pepper and banana has been practised for a long time.

The correct utilization of the space and growth factors available under coconut as part of a mixed farming system with either pasture for animal production or other crops may spell the difference between making a good or subsistence living for many of the coconut small holders in Sri Lanka.

Ecological considerations

In maintaining a pasture for grazing under coconut a complex ecological situation involving coconut, pasture species and animals is encountered. Each of these components while demanding certain conditions for their proper growth would at the same time affect the growth of the others. The more important aspects of the problem involved are: the effect of the pasture on the yield and life span of the coconut palm, the effect of the coconut on the growth,

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yield, persistency and nutritive value of the pasture and the efficiency of the available animal to convert the pasture into animal products. The same arguments would hold for intercropping coconut with annual, semi perennial or perennial crops.

Studies done at the Coconut Research Institute (CRI) show that there are no adverse effects on nut yield by intercropping with pasture provided both crops are adequately fertilized and grown in the more favourable rainfall regions. These studies further show that in fact there is a long term beneficial effect on nut production by intercropping with certain pasture species (Figure I).

These beneficial effects are no doubt due to the better recycling of nutrients, improvement in the soil structure and better water percolation characters exhibited by soils cropped continuously to pastures.

The main factor likely to limit the growth of pasture or any other intercrop under coconut is light. Studies done at the CRI show that during early morning and late afternoon the intensity of light in a coconut plantation where the palms were about 30 years old was 50% less under the canopy than in the open. During noon this light intensity increased to 60%. However in older stands the light intensities can be as high as 85%.

The light transmission through the coconut canopy depends on many factors including the age of the plantation, the spacing of the palms, the system of planting, the level of soil fertility and soil type and the orientation of the plantation in relation to the incident light. The amount of light reaching the ground cover will also vary with the time of the day, the season of the year, cloudiness and other factors. Although it has been shown that herbage will produce maximum yields only under conditions of full solar radiation there are plant species which exhibit varying degrees of shade tolerance. This should be an important factor for consideration in the choice of plants for intercropping.

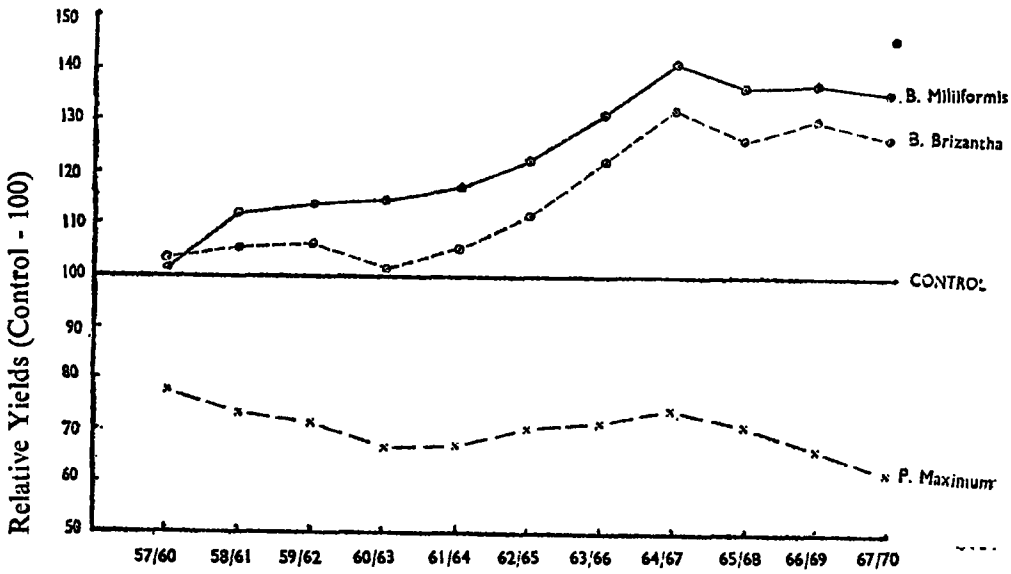

Fig 1. Four yearly moving averages of nut yield due to different pasture species and estate weeds (Control) at Lunuwila.

Another factor of great importance in animal production in the tropics is the high environmental temperature. It has been shown that this factor is responsible for the low voluntary intake and the reduced grazing period of temperate breeds of cattle in the tropics. Studies in Australia have shown that Jersey and Holstein cattle reduced their consumption of total digestible nutrients at temperature above 24°C while the Zebu breeds reduced their voluntary feed intake only at temperatures above 32°C. Thus air temperatures have a significant influence on livestock production since a reduced feed intake means reduced liveweight gains with a longer time being needed before the animals are ready for slaughter in the case of beef animals and reduced milk yields in the case of dairy animals. The encouraging feature in this respect in coconut plantations is that studies show that air temperature inside a coconut plantation is generally lower by about 6°C than in the open. This shows the feasibility of rearing better breeds of animals in coconut plantations.

Suitable species of pasture grass

The naturally occurring pasture species under coconut in the region are unproductive to be economically exploited. Further these species do not show sufficient response to added fertilizers. The yield of the naturally occurring pasture species at Lunuwila due to levels of added nitrogen are given in Table 1.

Table 1. *The yield of naturally occurring pasture species at different levels of added nitrogen*

Level of fertilizer	*D.M. Yield Kg/ha.*
20 kg N/ha	985
40 Kg N/ha	989
80 Kg N/ha	1003

It has been estimated that these naturally occurring pastures at their best have a carrying capacity of one animal to 2.3 hectares. Thus the only logical way to improve production in the region is to introduce new species with high yield and production potential.

The suitability of introduced species for any locality is measured in terms of production during the growing season, palatability, nutritive value and digestibility, tolerance and quick recovery from extremes of soil moisture conditions.

As a preliminary measure the CRI evaluated and compared the pasture species *B. miliiformis* and *B. brizantha* that had been introduced into the country earlier, for suitability to be grown under coconut. This study has shown that —

(1) *B. miliiformis* is less competitive than *B. brizantha* with coconut

(2) *B. miliiformis* respond more to added nitrogen under the shade prevailing under coconut than *B. brizantha*

(3) *B. miliiformis* withstands grazing and drought as well as *B. brizantha*

(4) Animal preference of *B. miliiformis* is more than that of *B. brizantha*

On the basis of these findings *B. miliiformis* has been recommended as a suitable pasture species for cultivation under coconut.

Subsequently a large number of species and varieties have been introduced for evaluation in this special environment. The yields obtained from some of these introductions with a fairly heavy dose of nitrogen application (200 kg N/ha/year) are given in Table 2.

Table 2. *The dry matter yields of pasture species grown under coconut*

Species	*D. M. yield kg/ha/year*
B. miliiformis	15,426
B. mutica	10,666
Paspalum commersonii	10,812
Paspalum notatum	13,193
Paspalum plicatulum	12,824
Digitaria decumbens	15,824
Panicum coloratum	8,919
Setaria anceps	14,268
Eurocloa mozambicensis	11,598

Use of Nitrogen for pasture production under coconut

When other factors were not limiting increased grass growth from the use of fertilizer nitrogen has been demonstrated in many areas of the tropics. In the Virgin Islands where fertilization of Pangola grass with ammonium sulphate in amounts equivalent to 0, 75, 150 and 300 kg of N/ha/year was done yields of 3.2, 4.7, 5.5 and 7.4 tonnes dry matter per hectare respectively have been reported.

It is well known that the growth potential of tropical grasses in areas receiving adequate rainfall is quite remarkable. The highest dry matter yields ranging from 11 to 34 tonnes per hectare per year have been reported from Puerto Rico.

Inadequacy of sunlight is the major limiting factor for obtaining high yields from pastures grown under coconut by the use of fertilizer nitrogen. However there appears to be large varietal differences in the response to added fertilizer nitrogen under the shade prevailing under coconut. In this respect both *B. miliiformis* and *Digitaria decumbens* appear to be satisfactory and the data obtained at Lunuwila are summarised in Table 3.

Table 3. *Levels of nitrogen applied and herbage dry matter yield of B. miliiformis and D. decumbens*

	D. M. yield kg/ha/year	
Level of N/ha	*B. miliiformis*	*D. decumbens*
20 ...	8111	8590
40 ...	11210	12435
80 ...	12360	12826
160 ...	13060	13291

The data indicate that substantial yield increases have been obtained at moderately high levels of applied nitrogen. The carrying capacity of these pastures is about 3.3 animal units/ha/year.

Mixed pastures

The role of a legume in a pasture is two-fold. The first is to increase the nutritive value and digestibility of the herbage and the second is the transference of nitrogen fixed by the legume to the grass. Animal production is a function of the daily intake of digestible dry matter and therefore depends on both the quantity of food eaten and the digestibility of the feed. As

the pasture matures the fibre content increases leading to a reduction in digestibility and voluntary intake. This decline is more marked in tropical grasses than in tropical legumes. Thus can be seen the importance of a mixed pasture in animal production particularly during the dry season when the grass feed on offer is very low in crude protein and digestibility.

Work done at the CRI has shown that considerable quantities of nitrogen are fixed by legumes like *Centrosema pubescens*. Further centro mixes very well with grasses like *B. miliiformis*, Pangola, *B. ruzuziensis* and Guinea grass. It has also been observed that *Centrosema* can withstand heavy grazing due to the fact that it has a number of dormant buds at the base of the stem that become active and continue to grow when the plant is eaten to almost ground level. However dry matter production from *Centrosema* is comparatively low.

Studies are in progress to investigate the mixing characters and animal acceptability of legumes like *Stylosanthus guyanensis* and Siratro. Shrub legumes like Ipil-Ipil and gliricidia are also being investigated.

Fertilizer requirements of pasture under coconut

The secret of obtaining high pasture yields combined with high coconut yields is to eliminate competition for nutrients between the two crops. Most coconut soils are deficient in N, P and K and an application of these three nutrients at least is essential for the successful integration of pasture production in coconut plantations. Further studies done at the CRI show that in an integrated coconut pasture system fertilizer placement plays an important part in avoiding competition for nutrients. Coconuts have to be manured in the usual way with the fertilizer placed around the base while the fertilizer for the pasture has to be applied broadcast. Studies carried out at the CRI show that optimum production for most of the listed pasture species was obtained at a nitrogen fertilizer application of 60 kg/ha/year. These yields were obtained with a basal application of 120 kg each of saphos phosphate and muriate of potash per hectare per year. Highest yields were obtained when the nitrogen was applied in split doses when conditions were favourable.

A suitable animal for the area

From the foregoing it is seen that the cultivation of suitable species of pasture plants can be integrated to the coconut planting system without any loss of coconut yields. The success of an animal husbandry project in this area therefore depends on the efficiency of conversion of the pasture produced into animal products.

32% of our national herd is known to be in the coconut growing areas. However the local cattle populations found in the region are the dependents of a primitive breed crossed indiscriminately to Indian and other breeds. This breed is called the "Sinhala cattle". The average weight of an adult Sinhala cow is about 200 kg yielding about 2.8 litres milk per day over a 250 day lactation under excellent management conditions. Various crossbreeding policies and attempts have been promoted and carried out in the past to improve cattle production in the region. Attempts have been made to improve the local cattle by crossbreeding with Indian breeds such as the Sindhi. However the improvement obtained has not been substantial for economic exploitation. Considerable attempts have been made to cross Sinhala cattle with temperate breeds. The popular temperate breeds used in this country have been the Jersey, Friesian and the Ayrshire. In all these crosses considerable improvements in yield have been recorded in the F_1 generation. It is well known that this increase in yield is due to hybrid vigour. However in all instances there has been a progressive decrease in yield in the subsequent generations. This drop in yield has been attributed to lack of adaptability. Attempts have also been made to backcross the F_1 to the two parent breeds. In both instances there had generally been a decrease in yield of the progeny.

Reviewing the data from all these exercises Mahadevan pointed out that "the conclusion is inevitable that in areas of medium agricultural potential in Sri Lanka a three breed rotational crossbreeding programme for milk production involving Zebu, Jersey and Friesian cattle has the greatest chance of success". Such a three way rotational crossbreeding programme involving the Sinhala and Sindhi, Jersey and Friesian breeds is in progress at the CRI and by this process it is hoped that the hybrid vigour is stabilised and a completely new breed can be evolved.