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Technical feasibility of Coconut (*Cocos nucifera*) Cashew (*Anacardium occidentale*) Intercropping System in *Puttalam* District, Sri Lanka

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Abstract

This study was carried out in *Puttalam* district of Sri Lanka during January to October 2013. Pure coconut, pure cashew and coconut-cashew inter-cropped stands were selected as treatments with three replicates each to record the yield data, growth measurements and for soil sampling. Questionnaire survey was conducted with farmers with relevant to same treatments. Land equivalent ratio (LER) was calculated to assess the yield advantages of intercropping over monocropping. The results revealed that there is a significant yield difference ($p<0.05$) of both coconut and cashew when monocropped and intercropped. Coconut and cashew yields were reduced by 49% and 30% respectively when intercropped than monocropped. There is no a significant difference ($p>0.05$) in major soil nutrients and organic matter availability of soil in coconut monocropped and intercropped stands. Sixty percent of farmers insert cashew into the coconut stand at the incorrect stage while 96% of farmers don't provide supplementary irrigation for their intercropped coconut stands. The findings conclude that though coconut yields are quantitatively lower when intercropped with cashew, combined yield of intercropped stand is higher (LER=1.28) indicating the beneficial effects of intercropping than monocropping. Majority of growers do erroneous agronomic practices for intercropped cashew under coconut, ultimately contributing to yield reductions of both crops.

Key words- *Coconut, Cashew, Land equivalent ratio, Monocropping, Intercropping*

1. Introduction

Intercropping is growing two or more crops in the same piece of land simultaneously which is also a widely practiced by farmers, especially in the tropics. It is an advanced agro-technique and is considered to be an effective and potential mean of increasing crop production per unit area and time, particularly for farmers with small holdings. The main concept of intercropping is to increase productivity and reliability of production. Moreover, intercropping gives a greater stability of yield over monoculture (14). Besides, it ensures greater resource use efficiency (12). One of the main reasons for higher yields in intercropping is that the component crops are able to use natural resources differently and make overall use of natural resources better than grown separately (17).

Coconut (*Cocos nucifera* L) is a widely grown perennial and 25% of the total cultivated lands in Sri Lanka are under coconut. Out of the three major perennials which are widely grown in Sri Lanka, coconut is the number one crop while the tea (*Camellia sinensis* L) and rubber (*Hevea brasiliensis* L) being the second and third highest. Coconut is mainly concentrated into few districts namely *Gampaha, Puttalum, Kaluthara* and

Kurunegala in the country while consisting in home gardens in rest of the areas.

Growing alternative crops under coconut is widely used practice by coconut farmers in the country which is mainly utilizing the advantage of wider spacing between trees. Increasing the land productivity by profitably growing other crops under coconut in specific ages of the coconut tree is the rationale of this practice. Coconut monoculture utilizes biophysical resources sub-optimally. In a mature coconut plantation, nearly 75 % of productive land area remains unutilized, because coconut has to be planted at a wide spacing (8 m x 8 m) to permit canopy growth and root distribution at maturity. And also, a mature coconut plantation utilizes only 44 % of total available light (7). In economic terms, monoculture coconut brings lower returns per unit land area. Successful intercropping increases returns from coconut plantations. A study in Western Samoa compared the profitability of a coconut monocrop with several intercropping possibilities. Results indicate that in all cases, intercropping receives returns more than doubles from coconut (9). Experiments conducted at the Coconut Research Institute of Sri Lanka demonstrate that intercropping with black pepper, cacao, cinnamon, coffee, and a variety of annuals increases coconut yields (3).

Cashew (*Anacardium occidentale L)*, is one cash crops which is grown with coconut in selected areas in Sri Lanka. Cashew is becoming an important cash crop for farmers in Sri Lanka where there is greater potential for increased production for the local market and export market. Presently, approximately 42,000 ha are under cashew plantations and produce around 10,000 MT of raw nuts which is only about 50% of the local demand (16). The national average yield of cashew is approximately 3-4 kg/tree/year**.** The annual raw cashew production is about 12,000 MT and average annual kernel production is about 2400 MT. Over 1500 MT are locally consumed and leaving only small quantity for export (16). More than half of the cashew extent is confined to the dry zone of the country. Amongst the main areas of cashew cultivation namely *Puttalam, Kurunegala, Batticaloa, Anuradhapura, Mannar* and *Hambanthota*, coconut cashew intercropping systems could be mainly identified in *Puttalam* district in commercial scale.

Being the both coconut and cashew are perennials, technical feasibility and other resulting factors in the long run of the coconut cashew intercropping systems have been studied less in the *Puttalam* district. This study mainly focused to explore the technical feasibility of this system in *Puttalam* district.

2. Materials and methods

This study was carried out in *Puttalam* district of Sri Lanka from January to October 2013. *Puttalam* district is situated at 8.09° North latitudes, 80.00° East longitudes and 212 meters elevation above mean sea level. Annual rainfall for the district is between 1000-1250 mm.

Few strategies were used in collecting data and information in the study. Field survey, laboratory analysis and questionnaire survey were them. Lands were selected representing three treatments namely coconut monocropping (T1), cashew monocropping (T2) and coconut-cashew intercropping (T3) from the study area with the size of one acre each. Three replicates were used in each treatment. Growth measurements of crops and yield data were collected for the investigation period from selected fields. Land equivalent ratio (LER) was calculated using below mentioned standard equation.

$$LER = \frac{\frac{Yield\ of\ intercrop}{coconut}}{\frac{Yield\ of\ monocrop}{coconut}} + \frac{\frac{Yield\ of\ intercrop}{cashew}}{\frac{Yield\ of\ monocrop}{cashew}}$$

Each field was divided in to three blocks and six soil samples were collected from each block. Composite soil samples were made from one block and three samples were drawn from each block for laboratory analysis. Available nitrogen content was determined by distillation method (1). Exchangeable Potassium content was determined by flame photometer method (15).Available Phosphorous was determined by Olsen's method (10). Organic matter content was determined by Walkley – Black method (8).

Questionnaire survey was conducted at *Puttalam, Wanathavilluwa, Anamaduwa, Mundal* and *Arachchikattuwa* areas in *Puttalam* district. Fifty pure coconut farmers, fifty pure cashew farmers and twenty five coconut-cashew intercrop farmers were interviewed. Farmers were selected by snowball sampling method. Data were analyzed statistically using SAS.

3. Results and discussion

3.1 Growth of the crops

Growth characteristics of the crops in intercrop and monocrop stands can display the compatibility of growing two or more crops in a system. Since both the crops are perennials, plant height and the diameter at breast height (DBH) were measured. The average plant height is higher in intercropped stand than monocropped stand of coconut (18.5 m and 16 m) while the DBH of monocropped stand is higher than intercropped stand of coconut (29cm and 27 cm respectively) while the both are not

significantly different (p=0.05). In case of cashew, the tree height and the DBH of the monocropped stand are lower (7m and 27cm respectively) than that of intercropped stand (8m and 29cm respectively) while two parameters are not statistically different (P=0.05). Generally in order to adjust with the available sunlight and spacing, the companion crops are higher in the intercrop stands than that f monocropped stands.

3.2 Crop yields

Mean yield of Coconut and Cashew in both monocropping and intercropping is shown in table 01. There is a significant difference ($p<0.05$) in yield of both coconut and cashew. Coconut yield varied from 3793 nuts/ac/yr to 1915 nuts/ac/yr. In the present study, coconut yield was reduced by 49% when intercropped compared to monocropped. In case of cashew, the intercropped yield is 14120 nuts/ac/year while the monocropped yield is 20200 nuts/ac/year while both are significantly also different ($P<0.05$). Fertilization was properly practiced in all the estates that field experiment was carried out and this may have resulted due to the competition for water between two crops.

Table 1: Yields of coconut and cashew (nuts/ac/yr) in monocropped and intercropped stands

Treatment	Coconut Yield	Cashew Yield
T1	3793 a	-
T2	-	20200 a
T3	1915 b	14120 b

Means followed by the same letter in each column are not significantly different

Experimental evidence shows that there would be no serious competition for soil moisture between coconut and intercrops if the annual rainfall is over 1900 mm. However in the intermediate zone and the dry zone, it will be risky to grow cashew and other long duration intercrops with coconut if irrigation facilities are not available (4). Severe drought was affected for *Puttalam* district during the year 2012. It is well known fact that long dry spells lead to lower the yield of coconut in the following year of the same period and also that generally yields low in the dry zone. Therefore, intercropping of coconut lands would be feasible if there is a sufficient ground water for these crops in dry zone (2). All the estates where the experiment was carried were observed with no supplementary irrigation is practiced for mature plantation and also did not apply any water conservation measures. This may be resulted for the reduced coconut and cashew yield in intercrop stands than the monocropped stands.

According to the survey data, 41% of farmers insert cashew when age of the coconut lies between 5-25 years receiving an average yield of 26 nuts/tree/year. However, Coconut Research Institute (CRI) of Sri Lanka do not recommend inserting cashew into coconut stands at this age.

Thirty seven percent (37%) of farmers have inserted cashew into coconut stands when the age of the coconut is more than the 25 years yielding an average of 57 nuts/tree/year. The recommendation of the CRI is to insert cashew into coconut stands after the 30-35 years age of the coconut stand in order to meet the agronomic requirements of the Cashew and ultimately to secure the yield of both crops.

According to the survey, 81% of farmers stated that coconut yield of their coconut-cashew intercropped stands are lower than the average yield. Out of the total, 15% of farmers mentioned that coconut yield is equal to average yield. Only 7.4% stated that coconut yield is higher than the average.

So most of farmers insert cashew to coconut land at the wrong age of the coconut stand. Ninety six percent of farmers did not practice supplementary irrigation for intercrop stands. These may also be affected to decline the coconut yield in coconut-cashew intercropped stands than monocropped stands.

3.3 Nutrient availability

In an intercropping systems, addition of the organic matter in the form of leaf letter and other forms by the growing crops to the growing soil is one of the important phenomenon. The coconut cashew intercropping systems, both the crops do not add much organic matter the growing soil (4). Therefore, ways of maintaining soil fertility in coconut cashew intercropping and monocropping systems through external application of nutrients is one of the essential management practice. The performance of the coconut monocropping and intercropping with cashew mainly depends on the nutrient situation of the soil. The competition for nutrient is one important criteria of a intercropping systems towards its compatibility. Therefore the availability of the major nutrients and organic matter of the coconut soil was tested in this study.

There was not significant different ($p>0.05$) in phosphorous, potassium and nitrogen content of soil in coconut monoculture and intercrop land as well as cashew monocropped and intercropped lands (Figure 2, 3 and 4). So cashew plants do not

compete for major nutrients with the coconut plants. At that sense cashew and coconut are compatible for each other for intercrop.

Even though more amount of leaves were collected in intercrop land than the monocrop land, soil organic matter content was also not significantly ($p>0.05$) different among intercropped and monocropped stands of both crops (Figure 5). This may be due to low degradation properties of cashew leaves and insignificant addition of organic matter by coconut trees into the cultivating lands.

3.4 Land Equivalent Ratio (LER)

One of the methods commonly used to assess the intercropping advantages of a system is the land equivalent ratio (LER), which is defined as the relative land area required for monocropping to produce yield obtain from intercropping (13). In present study LER is 1.28 indicating that the area planted under monoculture needs 28% greater area than the area planted under intercrop for the two crops to produce the same combined yields. This indicates the yield advantage of the intercropping system of cashew and coconut than both of the pure stands.

4 .Conclusion

Although growing of cashew under coconut quantitatively reduces both coconut and cashew yields, the total yield advantages intercropping cashew with coconut is beneficial than growing them in pure coconut (LER=1.28). Cashew trees do not compete significantly with coconut for major nutrients (N,P,K) and growing cashew with coconut do not enhance the organic matter content of soil. Since majority of the coconut farmers in *Puttalam* district does erroneous agronomic practices for intercropped cashew under coconut, ultimately contributing to reduce the yield of both crops, making farmers aware and motivation them to follow proper management practices for both crops when intercropped is needed.

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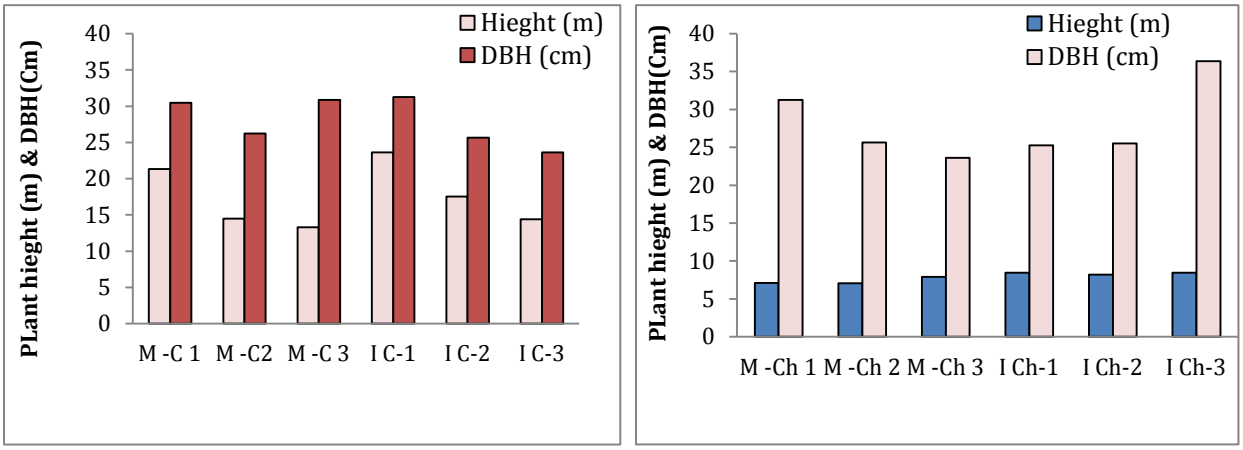

Figure 1: Plant height and DBH of pure coconut (M-C 1 to M-C 3) (Left) and pure cashew (M-Ch 1to M-Ch3) (Right) and intercrop stand (IC 1to IC 3 and ICh 1 to ICh3).

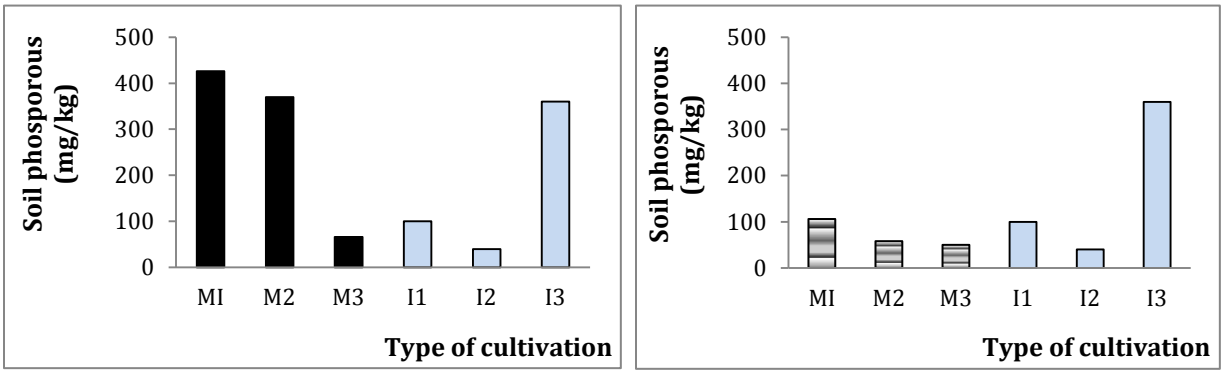

Figure 2: Available soil phosphorous content of pure coconut (M1-M3) (Left) and pure cashew (M1-M3) (Right) and intercrop stand (I1-I3).

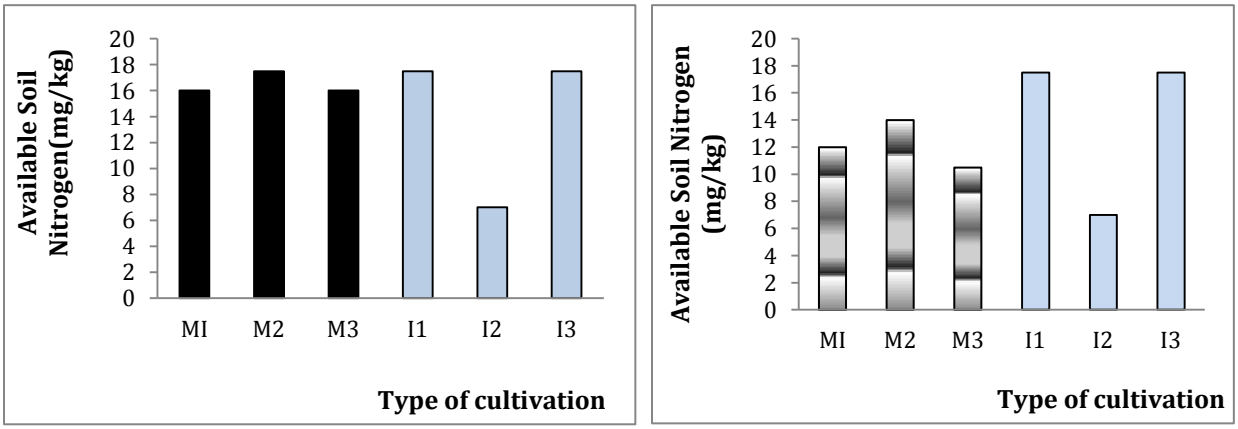

Figure 3: Available soil nitrogen content of pure coconut (M1-M3) (Left) and pure cashew (M1-M3) (Right) and intercrop stand (I1-I3).

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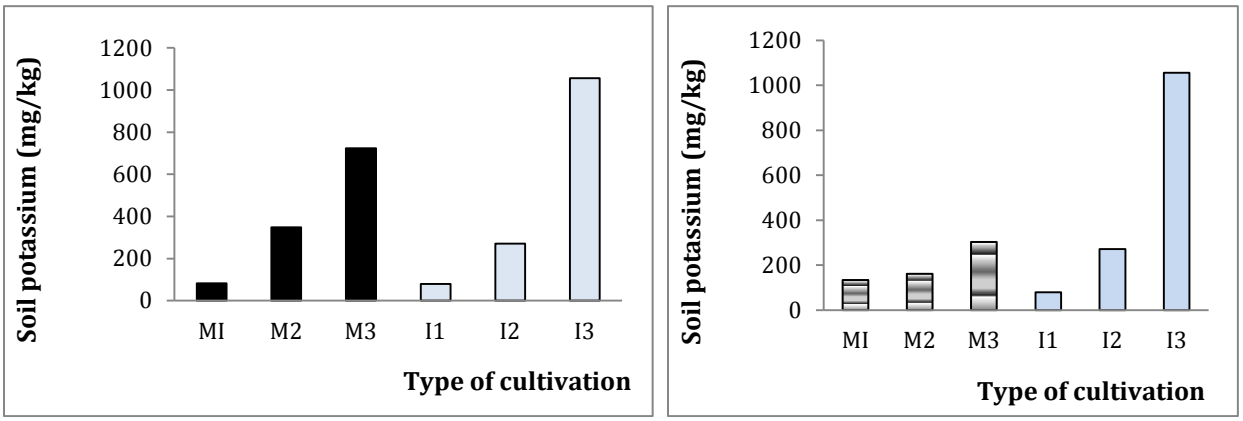

Figure 4: Exchangeable soil Potassium content of pure coconut (M1-M3) (Left) and pure cashew (M1-M3) (Right) and intercrop stand (I1-I3).

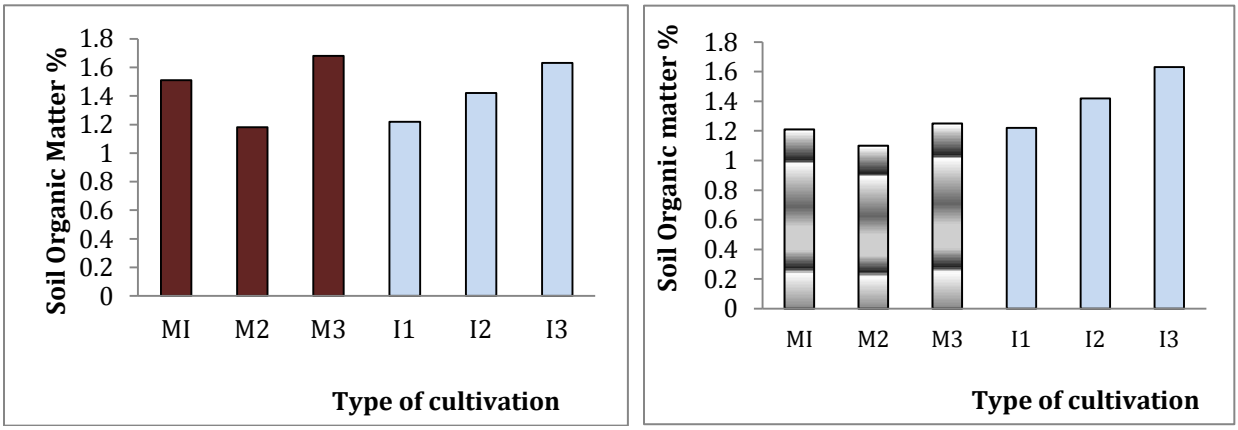

Figure 5: Soil organic matter content of pure coconut (M1-M3) (Left) and pure cashew (M1-M3) (Right) and intercrop stand (I1-I3).