Bulletin of the Rubber Research Institute of Sri Lanka, (2006) **47**, 40-43

A NEW SYSTEMATIC EXPERIMENTAL DESIGN FOR TREE CROP RESEARCH

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INTRODUCTION

Resources available for research are limited and are always less than what is desired. In the case of field experiments suitable land is scarce. Even if land is available conducting and managing experiments involving a large land area is very costly. This always tends the researchers to decide on the reduction of the size of the experiments that inevitably involves the reduction in the number of factors that has to be tested. Field experiments involving larger tree crops such as rubber needs a very large land area even to establish a simple experiment including few factors to test. In addition to the difficulty in finding suitable land, variation in the land and soil characteristics is so large and is a common feature particularly in rubber growing areas. This leads to a reduction in homogeneity of characteristics within replicates. Such large variation cannot be eliminated by replication because increasing the number of replicates will further increase the extent of land required which again extends the extent of land/soil variation and the burden of managing them.

In rubber where only 500 trees are planted per hectare, the smallest experimental plot used for intercropping research includes three rows of rubber. There have to be at least eight trees in a row, so that there will be six effective rubber trees on either side of which the intercrops are planted. With the inclusion of guard areas and with adequate replication, a very large land area is required even to test a few factors using the standard experimental designs. Management of such large experiments is also a difficult task.

In order to overcome these difficulties, a few selected treatments are usually compared with a standard, instead of testing a full range and such a selection have the deficiency of missing out the most promising treatments that need testing. This is a common occurrence when plant densities or special arrangements are tested. On the other hand the experiments with these perennial crops are always long term and conducting many short-term experiments testing few factors at a time is also not feasible.

In these instances 'Systematic' experimental designs that are commonly used in the case of field crops are very useful. Systematic experimental designs were first introduced by Nelder (1962) and their uses have been discussed in many instances (Huxley 1985, 1987).

Experimental design

The experimental design described here was adapted for an intercropping experiment established in 1998 (Pathiratna *et al.*, 2004). The objective was to test different inter row spacing systems of rubber for planting cinnamon as the intercrop. Realizing the disadvantage of selecting few spacing treatments at random without any prior knowledge on their suitability and with the risk of missing out the most promising spacings, a full range of spacings were tested. Spacings ranging from 7.2m that gave 579 trees-/ha to 18.0m- were therefore included in the experiment (Table 1).

The increase in the inter row space also decided the number of cinnamon rows included in the inter row. Therefore the spacing between two cinnamon rows was taken into consideration in deciding the inter row spacing treatments and all rubber spacings were taken as increments of 1.2m which is equal to the space between two cinnamon rows. The ten spacings selected for this experiment were 7.2m, 8.4m, 9.6m, 10.8m, 12.0m, 13.2m, 14.4m, 15.6m, 16.8m and 18.0m. The number of cinnamon rows in each of these treatments was 4, 5, 6, 7, 8, 9, 10, 11, 12 and 13 respectively. This facilitated testing of a wide range of inter row spacings of rubber and also a range of cinnamon plant densities/ha. in intercropping (Table 1). When the inter-row spacing of rubber was increased a corresponding decrease of the rubber trees per ha also takes place. As a remedy for this, paired rows of rubber were included in inter row spacings greater than 13.2m. Therefore each rubber treatment up to 13.2m had a single row of rubber while those from 13.2 to 18.0m had two rows.

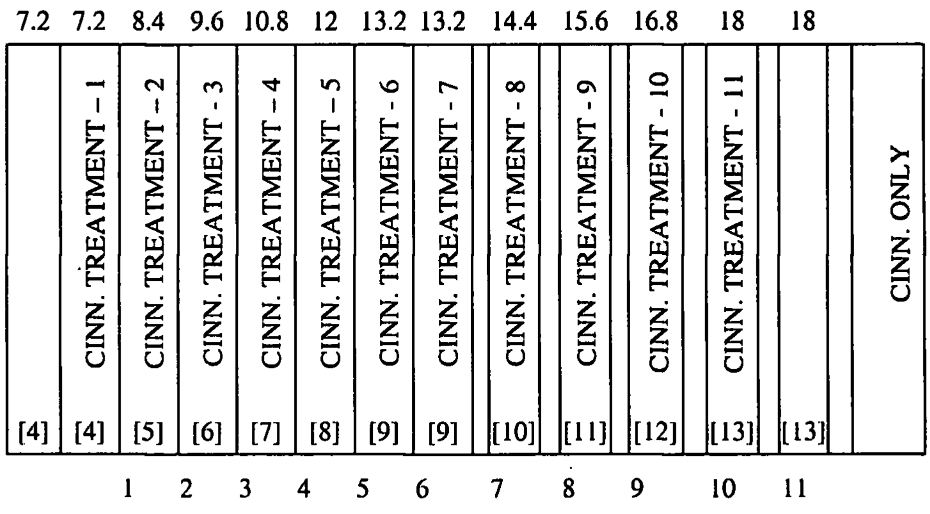

Diagram 1 The arrangement of treatments in a replicate in the experimental design. Figures 7.2 m –18.0m on top are inter row spacing treatments for rubber. Figures 1-11 in the bottom line are effective rubber rows and are the rubber treatments. Double lines represent paired rows of rubber. [ ]- Number of cinnamon rows in the treatments. Of the four replicates two were arranged east-west and the other two north-south. Only two guard areas were required on either ends of a replicate

Table 1. *Spacing, plot size and plant densities in each treat*

Inter row space (m)	Inter row area (m^2)	Rubber trees /ha	Cinnamon bushes/ha.
		Single rows	
7.2	156.0	579	9230
8.4	181.0	496	9940
9.6	207.0	434	10435
10.8	233.0	386	10815
12.0	259.0	347	11120
13.2	285.0	331	11368
		Paired rows	
13.2	285.0	545	9800
14.4	311.0	505	10100
15.6	337.0	471	10303
16.8	363.0	441	10582
18.0	389.0	415	10779

Data analysis

The data generated from this kind of design may be used in many ways through developing ratios such as, land equivalent ratio [LER], productivity equivalent ratio (PER), monetary advantage (MA) and income equivalent ratio (IER). Use of these indices needs some modifications before proceeding with standard statistical tools during the immature stage of rubber and was discussed in detail by Wijesuriya & Thattil, (2001). Yield density models also can be developed once rubber starts to yield in this experiment.

Uses, advantages and disadvantages

Parallel-row systematic-spacing is considered as suitable for this type of experiments with woody perennials as it can incorporate the sequential changes in factors such as plant density (Huxley 1987). Such changes in the level of interference from rubber on the intercrop that depends on the size of the inter-row space was measured in this trial. However, the major advantage was the limitation of the experimental area to about 2 ha. Guard rows for each and every treatment was not required. The reduction in the land area involved in the experiment minimized the land/soil variations that are difficult to eliminate otherwise. Standard experimental designs if used would have required about 15 ha to include these treatments with four replicates. However, this experimental design had the inevitable shortcoming of insufficient randomization of the treatments because the position of each treatment in the plot was pre determined. The deficiency can be remedied to some extent by increasing replication and such increases in the number of replicates do not increase the extent of land required greatly. Ease of management and low cost are the obvious advantages in this design.

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