Q. Jl. Rubb. Res. Inst. Sri Lanka (Ceylon) (1973) 50, 84—90

TRENDS IN THE IMPROVEMENT OF RUBBER PLANTING MATERIAL WITH PARTICULAR REFERENCE TO SRI LANKA

BY

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ABSTRACT

The early Hevea *selection and breeding programmes in Sri Lanka are described. The improvements achieved at the different stages are outlined. Selection is currently moving more towards better secondary characters such as disease and wind resistance, and vigour. The possibility of selecting suitable seedlings of* Hevea *by utilizing the parameter of oil content, and thereby shortening the selection cycle of* Hevea *by nearly twenty years is discussed.*

Subsequent to the introduction of the Wickham collection of *Hevea* from the Tapajos valley of Brazil, the area under rubber increased very rapidly. Thus the acreage under rubber in Sri Lanka increased from 1,750 ac. in 1900, to 40,000 ac. in 1905, 188,000 ac. in 1910, 460,000 ac. in 1920, 602,000 ac. in 1935, and now stands at 673,000 ac. approximately.

The 1920's saw the introduction of budgrafting methods and efforts were made to select outstanding clones and multiply them for use on estates. Though many such estate selections were isolated and multiplied, very few clones emerged at the earlys tages; Vischer & Tas (1922) showed that the high yield of a seedling tree which is not inherently high yielding, but which is phenotypically so, is not transmitted to the clone made from it. Hence the finally successful selections in Sri Lanka were very few and include, amongst others, Millakande 3/2, Wagga 6278, and Hillcroft 28. Such selections were also isolated and multiplied in other South East Asian countries and a few were imported into Sri Lanka viz,. PB 86, PR 107, Pil B 84, Pil A 44, PB 25, AVROS 157, and a few others: of these early selections an imported clone, PB 86, has found maximum popularity with growers to-date.

The development of improved cultivars in Sri Lanka

Improvement of *Hevea* material in Sri Lanka can be divided into 3 phases. The first phase comprises early selection and hybridizing of these selections from 1939 to 1945. The second phase from 1955 to 1969 utilized selections from phase 1 as well as material introduced from other countries. The third phase commenced in 1970 and re-introduced selection from clonal sources in addition to the usual bi-parental artificial pollinations.

Early introduced material such as PR 107, PB 86, Pil A 44, LCB 1320, and local selections such as Millakande 3/2 and Wagga 6278 were crossed in all possible combinations in the first phase of plant breeding from 1939-1945. Over 65,000 artificial pollinations were effected with 113 combinations of clones involving 25 female and 50 male parents. On the basis of the early yield test devised by Cramer a thousand plants were selected from 4,920 seedlings of known parentage; these seedling selections were multiplied and planted as single five tree plots in seven estates in 1947. Routine and test tapping of these selections was commenced in 1954 and during the period 1954 to 1960 75 selections were distributed to estates on demand for nucleus budwood. The results of large scale trial have just commenced to be reported and two clones, RRIC 36 of parentage PB 86 x PR 107, and RRIC 45 of parentage RRIC 8 x Tjir 1, have emerged as high yielding material. This first phase of plant breeding in Sri Lanka was directed mainly towards improvement of yields. However, the use of the widest range of available material also facilitated the delineation of combinations of clones "prepotent" for yields and vigour as described by Harland (1957) for coconuts. Therefore we were able for instance to confirm in Sri Lanka the transmissibility of vigour in clone AV 157 as reported from Indonesia and the transmissibility of yield by Tjir 1. Of local clones, Mil 3/2 x Wagga 6278 was found to be good combination and RRIC 7 (originally a PBIG seedling) was found to be a very satisfactory parent for yields. Analysis of the Phase 1 progeny also revealed that all the high yielding clones were well above average in girth as seedling though not all vigorous seedlings were necessarily high yielding.

The second phase of plant breeding commenced in 1955 and was conditioned by the emerging competition from synthetic rubber, and the development of *Oidium* leaf disease at epiphytotic levels, particularly on rubber grown over 1000 ft. above sea level. During this period a replanting subsidy was suggested for revitalization of both the rubber and tea industries and this subsidy was withdrawn for upland rubber: such rubber land was permitted to be replanted on subsidy with tea and favourable tea prices at that time, coupled with advanced methods of vegetative propagation of tea, evoked a ready change of crop. Even below 1000 ft. a lowering of yields became evident due to successive defoliation of young leaflets caused by the *Oidium heveae*. Therefore a clone resistant to *Oidium* was sought and LCB 870 was selected as the only clone available showing some resistance (Young, 1952). However, the yields of this clone were later shown to be uneconomic and the clone was withdrawn from planting recommendations. Later RRIC 52 emerged as a clone with approximately 20% leaf fall, resistance to *Oidium* leaf disease, and high transmissible vigour. Its yields were however found to be low in areas of lower rainfall: therefore this clone was not directly recommended for upland areas which are of lower rainfall. It also replaced LCB 870 in breeding programmes from 1957 onwards in an attempt to combine the high yields of clones such as PB 86 and RRIC 7 with the vigour, and leaf disease resistance of RRIC 52 (Fernando, 1968). During this second phase 136 clones were also imported from Brazil, *via* Kew, for incorporation of South American Leaf Blight (SALB) resistance in our breeding programmes. These clones (Baptiste, 1961) were induced to flower early by ring-barking and subsequent bending, and were then widely crossed with RRIC 52 and other local selections.

In 1959 and 1960, 268 selections from this second phase comprising LCB 870 and RRIC 52 progeny, and 111 imported SALB resistant selections were planted at almost nursery spacing in Kepitigalla Group (elevation 1,400 ft.) in order to assess resistance to *Oidium* leaf disease. Each clone was represented by two five tree plots. The epidemic of disease was so severe that it was later possible to thin the area and select on the basis of a Morris-Mann early tapping test. Only nine of our selections and two of the imported clones showed resistance combined with a sufficient yield of latex at this elevation. Two of these selections are RRIC 102 and RRIC 103. IAN 45-710 and IAN 6497 were the only SALB resistant clones to show resistance to *Oidium* and a satisfactory level of yield.

These seedlings from Phase II were also planted in an 80 acre small scale clone trial in 1961. The trial consisted of 10 tree plots with an additional five tree plot where possible. The accent on selection was for early opening and all trees over 16 in. in girth at four yr of age were brought into tapping at $4\frac{1}{2}$ yr of age. RRIC 100 of parentage RRIC 52 x PB 86, and RRIC 101 of parentage Ch 26 x RRIC 7, were selections made on this basis and RRIC 101 is in tapping on a 150 tree basis now. The *Oidium* resistant clone RRIC 103 has been similarly opened at five yr on a 300 tree basis and results appear very promising. Reduction of the seven yr immature period to five yrs leading to increased profitability of the crop therefore appears definite. The yields of these newer clones are shown in Fig. 1.

In the third phase of plant breeding commencing from 1970 an effort was made to combine the different sources of resistance, particularly SALB resistance, in order to achieve Van der Planks 'horizontal' resistance. This has had necessarily to wait till phase II progeny were tapped for at least one year in order to make certain that levels of yield could be maintained as at least at present (Table 1). Two procedures have greatly assisted selection at present. One of these is the technique of microtapping where a weighed filter paper is wrapped round a 3 to 9 month seedling and pricked at four places with a needle. A reproducible dry rubber content for each plant could be obtained by this method. Height and diameter could be measured at the same time and a very strict selection on the basis of yield and vigour could be effected. In our studies most clones yield a 10% selection on this basis. The second character that has come in useful is the oil content of the cotyledons of *Hevea* seedlings. Cotyledonary oil has been found to show an inverse relationship to growth and yield and has been found to show a higher heritability value than other characters. Investigations have also revealed a significant direct relationship between oil content and resistance to leaf mildew. Within the famework of these three or four parameters it should therefore be possible to select early for both clonal studies and commercial seedling production.

The latest selections that we have in tapping on a ·100 tree basis *viz*., RRIC 101 and RRIC 103, were synthesised in 1959. Twelve years is a relatively short period for a comprehensive test and twenty years appears to be essential for a multi-district test even with examination of early indices of yield (Fig. 2). The development of .eedling selection methods applicable in the field reduces this interval to zero. The yields from such material may of course be less than a selected clone but as the seedlings are selected on an equivalent basis the reduction of yield could not be expected to be very significant.

The selection of seedlings appears to be more effective from those parents showing a significant inverse correlation between growth and oil content. Such an inverse relationship has already been shown in the case of RRIC 45, Tjir 1 and RRIM 513 (Fernando & de Silva, 1971). Later work involving 31 clonal sources showed this relationship to be present in RRIC 103 and RRIM 607 seedlings.

The reduction of vigour with increasing oil content appears to be due to the presence of an inhibitor in the oil. This inhibitor was detected when the oil was fractionated by linear paper chromatography: the indentity of this inhibitor is still unknown to us. Hand sectioning and staining of *Hevea* leaves with Sudan IV showed the presence of a lipid layer in the epidermal cells of the leaf. It is possible that the retarding action of this inhibitor on growth may also operate on the germination of the pathogen. In order to further clarify these findings a method was sought to determine the oil content of mature plants. As chlorophyll presented a problem in ether or acetons extracts the roots of plants were next examined. Across a population from 31 clonal sources,

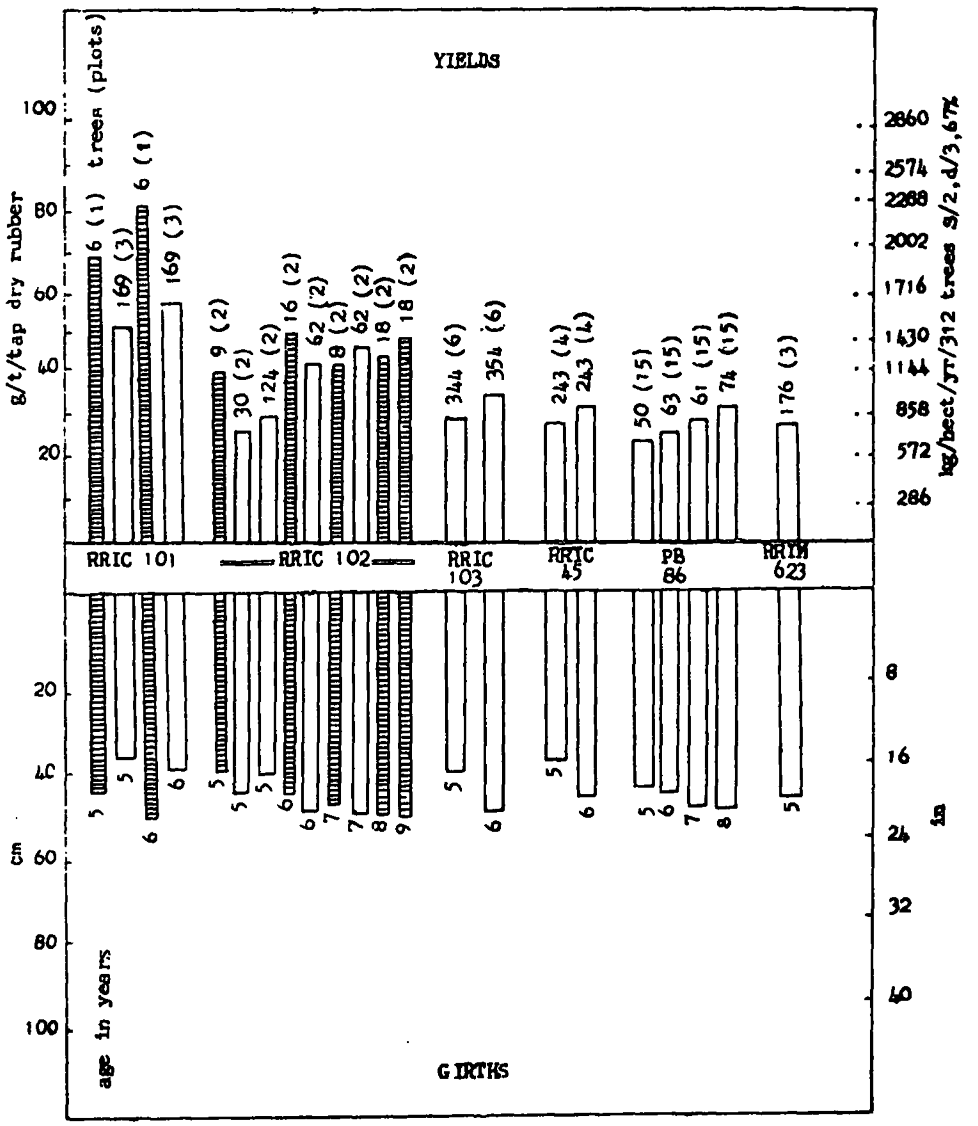
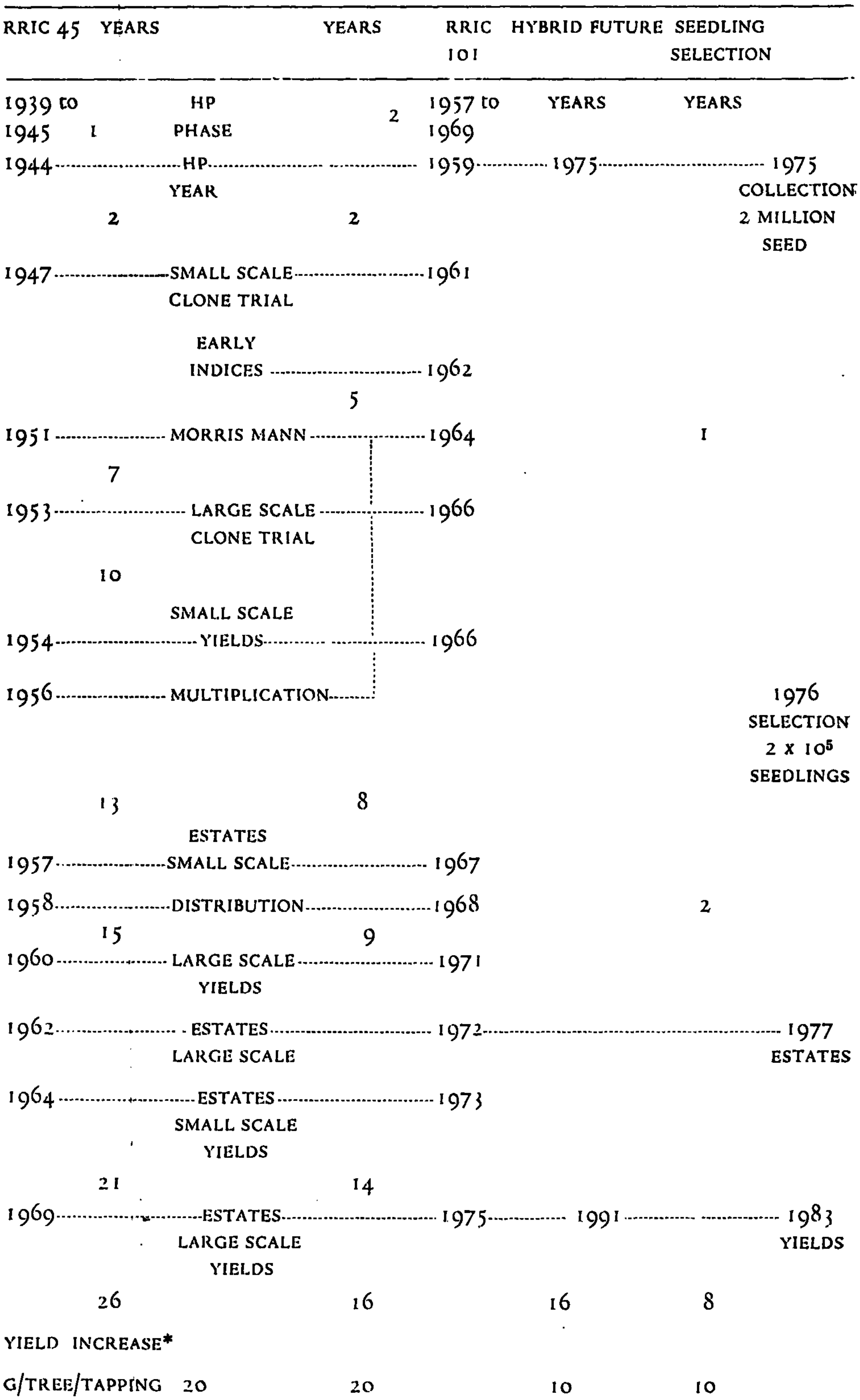


Fig. 1. Yield and Growth of some of the newer clones and controls.



*10 G/TREE/TAPPING APPROXIMATELY 150 TONS RUBBER/1000 AC./YR

Fig. 2 FLOW CHART FOR *HEVEA* BREEDING & SELECTION IN SRI LANKA

TABLE I

1965 SMALL SCALE CLONE TRIAL—DARTONFIELD

TAPPED S/2, d/3, 67% FROM 1970

Clone	Parentage	Trees tapped	Mean girth cm 1970	Mean girth cm 1971	Mean girth in. 1971	Mean girth cm 1972	Yield in g/tree/tapping 1970	Yield in g/tree/tapping 1971	Yield in g/tree/tapping 1972
6306	RRIC 36 x FX 516	7	47.9	53.7	21.1	59.2	23.9	34.9	32.0
RRIC 102	RRIC 52 x RRIC 7	4	49.7	53.3	20.9	59.7	25.8	32.4	35.4
2417	RRIC 45 x FX 4098	5	49.8	53.9	21.2	59.0	21.7	31.0	50.1
3164	LCB 1320 x RRIC 51	4	55.4	61.5	24.2	71.0	22.0	27.3	21.6
1461	RRIC 52 x T 792	10	55.0	59.5	23.4	65.4	20.0	27.2	27.1
2473	RRIC 45 x IAN 45-873	11	48.8	53.5	21.0	60.5	14.8	23.2	27.9
RRIC 45	RRIC 8 x Tjir 1	80	48.0	51.6	20.3	56.8	18.7	22.7	23.1
691	PB 86 x RRIC 52	4	50.6	57.5	22.6	64.8	13.1	20.9	21.1
2885	Ch 26 x RRIC 52	10	56.8	63.4	24.9	71.6	14.6	20.9	22.7
2416	RRIC 45 x FX 4098	13	54.6	61.4	24.1	70.8	16.7	20.8	18.6
5326	RRIC 51 x F 4542	11	48.8	54.9	21.6	60.2	16.2	20.5	18.5
5352	RRIC 52 x IAN 45-710	13	52.6	61.2	24.0	68.9	13.6	18.8	18.8
6182	PB 28/59 x IAN 45-873	11	50.8	57.1	22.4	64.0	14.7	18.7	24.7
IAN 45-710	PB 86 x F 409	4	44.9	51.1	20.1	58.2	13.7	16.9	16.8
RRIM 623	PB 49 x Pil B 84	9	48.9	53.7	21.1	60.3	16.2	16.1	17.4
RRIC 106	PB 5/139 x RRIC 52	13	54.9	58.9	23.1	64.4	16.0	14.4	15.9

a significant inverse relationship was detected between oil content of the cotyledons and that of the roots (Fernando & de Silva—paper in preparation). This complicates the problem of selection but would explain the short lived 'vertical' resistance to mildews in seedlings. Though selected seedlings may be desirable for immediate use and growth under adverse circumstances, routine hybridization is also necessary for the production of specific families in the continuous search for the improved rubber tree.

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