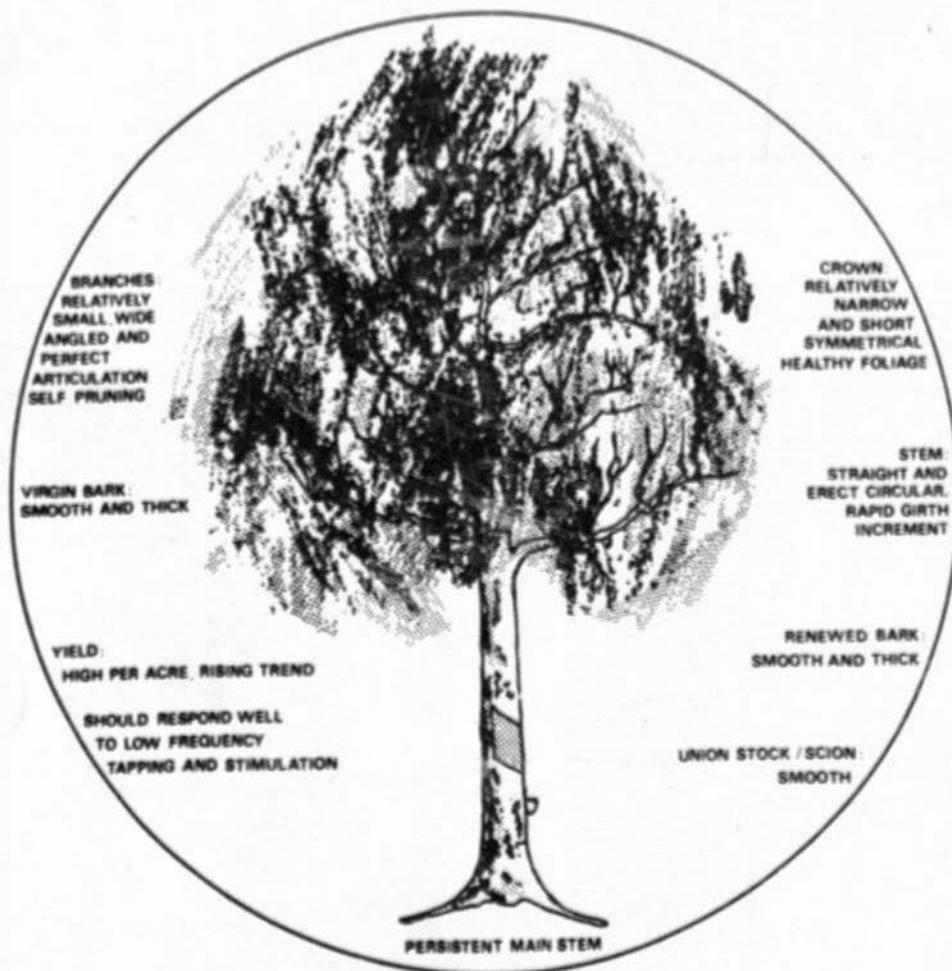


CLONAL PLANTING RECOMMENDATION AND ITS IMPLEMENTATION IN SMALLHOLDINGS



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CLONAL PLANTING RECOMMENDATION AND ITS IMPLEMENTATION IN SMALLHOLDINGS

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GLOBAL READING RECOMMENDATION
AND ITS IMPLEMENTATION
IN SMALL SCHOOLS

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PENDAHULUAN

Sebagai asas daya hidup Perusahaan Getah Asli Malaysia, kebun kecil harus dipermodenkan supaya perusahaan ini maju. Laporan ini mempertimbangkan tekanan yang menentukan perlakuan klon dan membuat pengesyoran untuk berbagai jenis kebun kecil itu. Beberapa kaedah dan cara untuk penanaman bahan klon dijelaskan. Percubaan yang membandingkan perolehan pada padat menanam yang berbeza menunjukkan bahawa perolehan tiap hektar bertambah dengan penambahan padat dan daripada percubaan ini, bilangan pokok optima sehektar didapati.

Dalam penyediaan laporan ini, penghargaan ditujukan kepada ramai. Bagaimanapun, ucapan khas patut dibuat ke atas sumbangan yang diberi oleh penyelidik-penyelidik. Penghargaan juga diberi kepada Cik Sim Lee Ling kerana menyunting dan memproses laporan ini, Encik Hoh Lian Yong dan kesemua pelukis grafik, dan Encik A. Gopalan kerana kerja melukis dan menggambar, Puan Margaret Lau dan Puan Nancy Chong kerana menaip dan Encik Yusup bin Abdullah kerana mencetak laporan ini.

Haji Ani bin Arope
Pengarah
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PREFACE

Smallholdings, the basic life force of the Malaysian NR Industry have to be modernised if the industry is to progress. This report considers the constraints determining the performance of clones and make recommendations for the various types of smallholdings. Various techniques and procedures for the establishment of clonal material are detailed. Experiments comparing yields at different planting densities indicate that the yield per hectare increases with the density and from these experiments, the optimum stand per hectare is obtained.

In the preparation of this report, acknowledgement is due to many. However, special mention must be made of the contributions of the research workers. Acknowledgement is also due to Cik Sim Lee Ling for editing and processing of the report, Encik Hoh Lian Yong and all the graphic artists, and Encik A. Gopalan for attending to the illustrative work, Puan-Puan Margaret Lau and Nancy Chong for typing and Encik Yusup bin Abdullah for printing this report.

Haji Ani bin Arope
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RINGKASAN

oOo

SYNOPSIS

RINGKASAN

Walaupun sektor pekebun kecil mempunyai 64% dari jumlah kawasan di bawah penanaman getah, sumbangan dari pekebun kecil adalah rendah. Jika purata perolehan dari pekebun kecil boleh ditambahkan kepada 2000 kilogram sehektar pendapatan mereka sudah tentu akan bertambah. Ini boleh dicapai dengan mengganti semua pokok yang memberi pengeluaran kurang dari 1500 kilogram sehektar di waktu perlakuan tertingginya dengan klon yang berperolehan lebih dari 2500 kilogram sehektar.

Varieti berperolehan tinggi begini telah dihasilkan baru-baru ini untuk kegunaan perdagangan. Perlakuan satu-satu klon berbeza dari satu tempat ke tempat lain disebabkan oleh tindakbalas keupayaan bakanya dengan sifat-sifat sekeliling. Konsep baru pengesyoran menanam ENVIROMAKS mempertimbangkan tekanan berbeza seperti kerosakan oleh angin, kejadian penyakit dan sifat tanah yang menghalang perlakuan klon. Panduan terator untuk memilih klon bagi environ (alam sekeliling) tertentu memberi pertolongan besar kepada pekebun kecil. Faktor-faktor sosio-ekonomi yang terdapat di sektor-sektor berbeza itu telah memaksa mengadakan pengesyoran menanam yang berasingan. Penanaman lebih dari satu klon disyorkan kepada tiap kebun kecil sebagai satu jaminan terhadap kerugian perolehan yang tidak dijangka, iaitu hasil dari penukaran corak penyakit yang disebabkan oleh kuman penyakit.

Penyediaan jenis-jenis bahan menanam yang berbeza daripada pengumpulan biji kepada mencedung, memberikan satu panduan yang sangat berguna untuk penanaman yang berkesan. Rajah yang diringkaskan itu sangat berguna untuk cadangan akan datang. Jika langkah-langkah kawalan musuh dan penyakit diikuti dengan betul, bersama dengan pembajaan yang cukup, bahan menanam yang baik akan didapati. Berbagai cara yang diterangkan telah diuji untuk kebun kecil oleh Pusat Penyelidikan Getah Malaysia.

Pertimbangan ekonomi yang diberi menimbangkan dua faktor penting iaitu bilangan pokok sehektar dan kos pengeluaran jenis

bahan menanam yang berbeza. Untuk menambahkan pendapatan dari kebun kecil, terutama yang berukuran kecil, penanaman yang lebih padat terdiri dari 600 ± 25 pokok sehektar disyorkan.

Keuntungan jangka panjang mengesahkan belanja lebih yang terlibat dalam penanam bahan menanam yang lebih baik. Hitungan menunjukkan bahawa cantuman beg politin atau anak cantum pancung (waktu untuk matang selama empat tahun) memerlukan belanja tambahan maksima sebanyak \$1519 sehektar dan tunggul mini (waktu untuk matang selama lima tahun) memerlukan \$712 sehektar lebih dari tunggul cantuman (waktu untuk matang selama enam tahun).

SYNOPSIS

Although the smallholder sector occupies 64% of the total hectarage under rubber, contributions from smallholders are low. If the average yield from smallholders can be increased to 2000 kg per hectare their income will be increased substantially. This can be achieved by replacing all the trees which yield below 1500 kg per hectare during their peak performance with clones which yield above 2500 kg per hectare.

Such high-yielding varieties have been produced recently for commercial adoption. The performance of individual clones varies from region to region due to the interaction of their genetic potential with environmental characters. The new concept of ENVIROMAX planting recommendation takes into consideration the different constraints such as wind damage, disease incidence and soil characteristic which impede performance of the clone. The step by step guideline for the choice of clones for a specific environ should greatly assist smallholders. The socio-economic factors present in the different sectors of the industry have necessitated the formulation of separate planting recommendations. The planting of more than one clone is recommended for each smallholding as an insurance against unforeseen yield losses resulting from change in disease pattern due to pathogen build-up.

The preparation of different types of planting materials, from seed collection to transplanting, provides a valuable guide for effective implementation. The simplified flow chart is useful for forward planning. If pest and disease control measures are carefully followed in conjunction with adequate manuring healthy planting materials will be obtained. The various techniques described have been tested in smallholdings by the Rubber Research Institute of Malaysia.

The economic consideration presented takes into account two important factors i.e. stand per hectare and cost of production

of the different types of materials. In order to increase the income on smallholdings, especially those which are uneconomic in size, a higher planting density of 600 ± 25 trees per hectare is recommended.

The long-term benefits justify the extra expenditure involved in the establishment of the more advanced planting materials. Computations show that polybags or stumped buddings (four-year immaturity period) and mini stumps (five-year immaturity period) can incur respectively a maximum additional expenditure of \$1519 and \$712 per hectare relative to budded stumps (six-year immaturity period).

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CHAPTER I

INTRODUCTION

CHAPTER I

INTRODUCTION

Peninsular Malaysia is estimated to produce about 2.1 million tons of natural rubber in 1980. For natural rubber to stay in a competitive position it has to be produced at the lowest possible price. This can be achieved by:

- o Increasing the output per unit area.
- o Decreasing the cost of production per unit area.

Hevea breeders and selectionists are continually endeavouring to fulfil this requirement by recommending the right type of planting material to the estate and smallholder sectors of the industry.

Breeding and selection of rubber are carried out by the Rubber Research Institute of Malaysia and Prang Besar Research Station. The Rubber Research Institute of Malaysia's priorities have been on the production of clonal material and recently, genetic studies, whereas the Prang Besar Research Station has been giving equal emphasis to the production of both improved seedlings and clones.

Because of the perennial nature of the crop and the rapid rate at which tree productivity is being increased, a planting material rated as high yielding and planted today may be rated as low yielding in ten to fifteen years' time even though its yield may be at its peak. This has been found to be true for materials planted fifteen to twenty years ago, for example seedlings such as Tjir 1 monoclonal and polyclonal and clones Tjir 1 and PB 86 were considered to be high yielding and were recommended for large-scale planting during the early fifties but during the early sixties these were superseded by higher yielding clones such as RRIM 605, RRIM 623, PB 5/51 which were in turn superseded by RRIM 600 and GT 1. The

clones which are currently in the pipeline are very much higher yielding but their use has not been encouraging because they are only recommended for experimental planting. By the time they are recommended for large-scale planting their use will be limited by the area available for replanting.

In order to remedy such a situation, the estate sector is advised to take calculated risks by planting a limited acreage with some of the speculative clones. This recommendation is not practical in the smallholder sector because of the small size of the individual holding.

The nature of the smallholdings and the smallholder demands a separate planting recommendation.

Objectives of the Report

The objectives of this report are:

- o To consider the various constraints which determine the performance of clones and make recommendations accordingly.
- o To make clonal planting recommendations for the various types of smallholdings.
- o To detail the various techniques and procedures of establishment of clonal material and the related operations.
- o To recommend the optimum stand per hectare in terms of economic considerations.
- o To recommend the planting of clones using the various techniques which can be implemented smoothly.

CHAPTER II

REVIEW OF WORK ON CHOICE OF CLONES

CHAPTER II

REVIEW OF WORK ON CHOICE OF CLONES

Basis for New Approach

Prior to 1968, recommendations of planting materials were based on the yield performance of the clones and the degree of confidence that their potential will be realised in commercial planting. The secondary characteristics, if adverse, tend to restrict the use of the clones for wide scale planting. To provide the background for the development of a new approach of tailoring recommendations to meet the needs of a particular locality, the shortcomings of this general method of planting recommendations and some of the steps taken to overcome these problems are discussed in more detail in the following sections.

Shortcomings of the Non-discriminatory Method of Planting Recommendations

The general planting recommendations do not consider in detail the interaction of inherent clonal characteristics with the characteristics of the environment. As a result, heavy wind damage losses occurred in PB 5/63, RRIM 501, 513, 605, 623 and LCB 1320; severe pink disease in RRIM 501, 600 and 701; heavy incidence of various leaf diseases in PB 86, 5/51, 5/51, 5/63, RRIM 526 and 600 when these were exposed to predisposing conditions in various parts of the country.

Only a small number of clones can be recommended for general large-scale planting because many high-yielding clones are discarded due to one or more serious defects in their secondary characteristics.

Another disadvantage is that it takes a long time for a clone to acquire the status of being recommended for large-scale planting. In the past, the performance of materials must be

confirmed by records from commercial planting to qualify for a higher class rating. This has contributed to the vast disparity between the tremendous potential performance of the new clones and the practical realisation of that potential in commercial planting.

Inherent Clonal Characteristics and their Modifications

Recent data suggest that it is no longer sufficient to base recommendations on the inherent characteristics of the clone. The environmental factors - incidence of wind damage and disease and soil type have been shown to contribute to the variable performance of clones in different regions. The rubber-growing areas have been demarcated into different regions where the influence of these environmental factors is significant. This forms the initial phase of refining planting recommendations to suit local needs (Ho et al.¹, Ng et al.²).

The recent major development of crown budding has widened the choice of planting materials available to the planting industry (Yoon³). The correct choice of the crown clone can:

- o Improve the resistance to diseases.
- o Improve vigour.
- o Reduce wind damage losses.
- o Reduce seasonal yield variations of the trunk clone.

Therefore, crown budding has enabled the use of high-yielding trunk clones which had previously been discarded. However, since large-scale trial results with modern clones are not yet available, crown budding is not ready for general recommendation on smallholdings, but only on project basis.

¹Ho, C.Y., Ng, A.P. and Subramaniam, S. (1969) Choice of clones. Plrs' Bull. Rubb. Res. Inst. Malaya No.104, 226.

²Ng, A.P., Sultan, M.O. and Yoon, P.K. (1972) Selection of crowns for top working. Proc. Rubb. Res. Inst. Malaya Plrs' Conf. Kuala Lumpur 1971, 154.

³Yoon, P.K. (1972) Further developments in the establishment of three-part-trees. Proc. Rubb. Res. Inst. Malaya Plrs' Conf. Kuala Lumpur 1972, 73.

Influence of the Environment on Performance of Clones

Susceptibility to wind damage. Wind damage, unlike disease, usually results in permanent loss of the trees. This problem is further aggravated by damage often occurring at a time when replanting is uneconomic. The various factors affecting the severity of loss through wind damage are:

- o Inherent clonal susceptibility.
- o Management practices such as exploitation system, planting density and thinning, ground covers and manurial policy.
- o Edaphic and climatic factors such as soil type, terrain and wind speed and frequency.

Insufficient attention to these aspects has occasionally caused loss of entire plantations.

Clonal susceptibility and cultural practice. Clones differ in their susceptibility to wind damage. Poor girdling during tapping, heavy and unbalanced crown development and excessive tree and canopy height are among some well-established predisposing characteristics inherent in some clones. Various cultural practices can magnify these characteristics.

Tapping reduces growth, and if severe, may induce an imbalance between crown and trunk growth, leading eventually to wind damage. Premature opening can give rise to the same condition and has resulted in higher wind damage losses in RRIM 501⁴.

Incidence of wind damage is highest soon after refoliation. when canopies are heaviest; there is no wind damage when trees are bare during the wintering period. Rosenquist⁵ reported that increasing applications of either nitrogen or phosphorus led to heavier wind losses while absence of manuring resulted in fewer trunk snap

⁴Rubber Research Institute of Malaya (1959) Wind damage. Plrs' Bull. Rubb. Res. Inst. Malaya No.43, 79.

⁵Rosenquist, E.A. (1961) Manuring of rubber in relation to wind damage. Proc. nat. Rubb. Res. Conf. Kuala Lumpur 1960, 81.

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cases. This has been attributed to heavier foliage development resulting from larger fertiliser applications. Work done at the R.R.I.M.⁶ on wood strength and nutrient content indicated that high potash content led to poor wood strength, but the effects were not significant.

Tall, spindly growth, a discontinuous canopy and leaning towards the inter-rows encourage wind damage. This is enhanced by wide avenues and hedge systems of planting. Wide gaps in the stand also contribute to wind damage. This can arise when thinning is delayed or not staggered.

While clones and cultural practices can be varied, the soil type, terrain and incidence of wind in a particular environment are fixed. The relationships of incidence of wind damage and soil type, depth and terrain are discussed elsewhere in this chapter.

Incidence of wind in Peninsular Malaysia. Peninsular Malaysia does not often encounter severe storms experienced elsewhere in the tropics⁷. In general, wind velocities are quite low.

The following generalisations on incidence of wind can be made. Wind velocity and incidence of strong gusts tend to increase in the coastal and hilly areas, while low inland districts are relatively calm. The greater part of the east coast up to Kuala Trengganu in the north, is very windy and the same seems to be true of the west coast from Singapore up to Bukit Jeram.

This outline of the incidence of wind in Peninsular Malaysia helps to explain why wind damage has been more severe in some districts and indicates where special precautions should be taken. Even in certain districts which are less wind prone, features such as funnel-shaped valleys can concentrate the wind and thereby cause damage to the rubber trees.

⁶ Rubber Research Institute of Malaya (1961) Open discussion. Cover plants, manuring and wind damage. Inst. Malaya No.56, 163. Plrs' Bull. Rubb. Res.

⁷ Ho, C.Y. et al. (1969) op. cit.

Prevention of wind damage. Commercial and trial data indicate that wind susceptible clones encounter varying degrees of wind damage when grown in different regions.

In many areas, RRIM 501 suffers from serious trunk snap unless the trees have been pruned or pollarded. In others, wind damage is negligible or within acceptable limits. Commercial plantings in Johore and Kedah suffer less than those in Central Peninsular Malaysia⁸. Data from our Commercial Register clearly differentiate between the yields of RRIM 501 fields, that are mildly and seriously affected by wind damage (Table 1). In fields where there is little damage, yields are high.

TABLE 1. MEAN YIELD OF RRIM 501 IN FIELDS WITH MILD WIND DAMAGE AND FIELDS WITH SERIOUS DAMAGE
(Kilogram per hectare)

Wind damage	Year of tapping							
	1	2	3	4	5	6	7	8
Mild	615	996	1 337	1 543	1 734	1 847	1 805	1 807
Serious	628	971	1 267	1 387	1 433	1 353	1 281	1 232

Table 2 shows that in clonal trials, losses through wind damage vary between locations. Losses in wind prone areas can be from six to sixteen times more than in less windy districts.

TABLE 2. INCIDENCE OF WIND DAMAGE IN CLONAL TRIALS IN WINDY AND NON-WINDY LOCATIONS

Trial	No. of clones	Trees/ha lost and stumped		
		Windy	Moderately-windy	Non-windy
RRIM 700 series clones ^a	16	62	-	4
Foreign exchange clones ^b	91	92	39	15

^aLosses over five years

^bLosses over ten years

⁸Rubber Research Institute of Malaya (1965) Performance of clones in commercial practice: first report. Plrs' Bull. Rubb. Res. Inst. Malaya No.76, 25.

Table 3 shows that in non-windy areas, the clones may be tolerated unless very susceptible to wind damage. It also emphasises the importance of wind fastness when choosing clones for wind prone locations.

TABLE 3. INCIDENCE OF WIND DAMAGE OF SELECTED CLONES IN WINDY AND NON-WINDY LOCATIONS

Clonal susceptibility to wind damage		Trees/ha lost and stumped (10 years)	
		Windy ^a	Non-windy ^b
Low	PB 5/51	16	0
	PR 107	17	2
Moderate	RRIM 623	76	9
	PB 5/63	120	9
High	RRIM 501	194	22
	RRIM 614	287	244

^aBE. 224 - Inland Selangor

BE. 245 - Inland Selangor

^bBE. 222 - Inland Malacca

BE. 226 - Inland Negri Sembilan

Wind damage regions. A survey on wind damage was conducted in 1969 using widely planted wind susceptible clones, RRIM 513, 603, 605, 623, PB 5/63 and LCB 1320 budded between 1956 and 1959⁹. This survey has enabled a broad delineation of rubber-growing areas into different regions according to degree of wind damage incidence. Results of this survey agree well with those obtained in clonal trials but differ from results of an earlier survey of trunk snap in RRIM 501 which suggested that abnormal wind conditions are of less importance than inherent trunk snap susceptibility (Wycherley¹⁰).

Rubber is not uniformly distributed over Peninsular Malaysia and the incidence of wind damage must be evaluated in the light of the actual location of the areas and wind incidence. For

⁹Ho, C.Y. et al. (1969) op. cit.

¹⁰Wycherley, P.R. (1963) Variation in the performance of Hevea in Malaya. J. Trop. Geogr. 17, 143.

example, very little rubber is grown along the east coast but the high incidence of wind in the coastal region extending from Johore to Kuala Trengganu suggests that we should expect at least moderate damage to occur. Most wind damage appears to have been sustained along the coasts of Selangor and Negri Sembilan and parts of coastal Malacca - the strip between Malacca and Bukit Jeram. Wind damage is also severe near Bentong in Pahang and the western side of coastal Johore. It is relatively light in Kelantan, Central and North Kedah. Province Wellesley, South Kedah, a belt in Perak and another in Johore and South Johore encounter moderate wind damage.

Clonal Susceptibility to Diseases

Until recently, above-ground diseases of rubber had not been considered as a major limiting factor to optimum tree performance and yield in Malaysia. None of the leaf-infecting fungi approaches in severity the devastation caused in South America by Microcyclus ulei or the defoliation caused by Phytophthora palmivora in India and in Ceylon by Oidium heveae. In part this is due to the climate: although monsoonal in the east coast, on the west where most rubber plantations are located, continuous wet weather does not occur frequently, rainfall being generally confined to short periods in the afternoons. Thus the foliage is usually dry by mid-mornings and periods of weather favourable for the spread of leaf infections occur only at night (Wastie¹¹). Nevertheless, leaf and stem diseases have become more severe in the last fifteen years or so, and this may be attributed to the higher disease susceptibility of modern high-yielding clones which have been extensively planted. The successful search for ever higher yielding planting material has been carried out at the expense of resistance to diseases.

Secondary leaf fall caused by Oidium heveae and Colletotrichum gloeosporioides are more important because of their widespread distribution. Pink disease caused by Corticium salmonicolor is virtually absent on coastal Peninsular Malaysia; in inland regions, this disease as well as black stripe caused by Phytophthora

¹¹Wastie, R.L. (1972) Factors affecting secondary leaf fall of Hevea in Malaya. J. Rubb. Res. Inst. Malaya, 23(3), 232.

spp are becoming more severe and widespread towards the north of the country (Hilton¹²). *Phytophthora* leaf fall is confined only to Pulau Langkawi and limited areas on the mainland in the extreme north-west and south-west (Chee et al.¹³).

Leaf diseases. Three leaf diseases are of importance in Malaysia: *Oidium* leaf disease and *Gloeosporium* leaf disease which are endemic and result in secondary leaf fall (SLF) and since 1966, *Phytophthora* leaf fall caused by *P. palmivora* and *P. botryosa*. The first two diseases, most prevalent in the country, are particularly important because they cause defoliation of the new leaves produced in March and April immediately after the annual wintering. Where SLF is habitually severe, repeated attempts at refoliation divert metabolites from latex production and the depression in yield which normally occurs after wintering is excessively prolonged. Repeated SLF also results in reductions in the rate of girdling and bark renewal. On young plants both in the nursery and in the field, SLF can also cause extensive leaf damage or defoliation of the developing canopy causing setback to growth and in extreme cases, death of the affected tree.

The severity of SLF depends on the weather, the speed of wintering and refoliation, and the innate susceptibility of the planting material. Although SLF has been of annual occurrence since 1928, it appears to have become more common, and its effect more severe in post-war years. From annual surveys of the severity of SLF on some of the common cultivars conducted over the last eighteen years, a broad picture of the geographical distribution of *Oidium* and *Gloeosporium* leaf diseases has been obtained (Figures 1 and 2; Wastie¹⁴). Incidence of *Oidium* leaf disease is highest in West Johore, Malacca, coastal Negri Sembilan, coastal Perak and Kedah while that of *Gloeosporium* leaf disease is highest in Central and

¹²Hilton, R.N. (1959) *Maladies of Hevea in Malaysia*, p.101.
Kuala Lumpur: The Rubber Research Institute of Malaya.

¹³Chee, K.H., Lim, T.M. and Wastie, R.L. (1967) An outbreak of *Phytophthora* leaf fall and pod rot on *Hevea brasiliensis* in Malaysia. *Pl. Dis. Repr.* 51(6), 444.

¹⁴Wastie, R.L. (1972) op. cit.

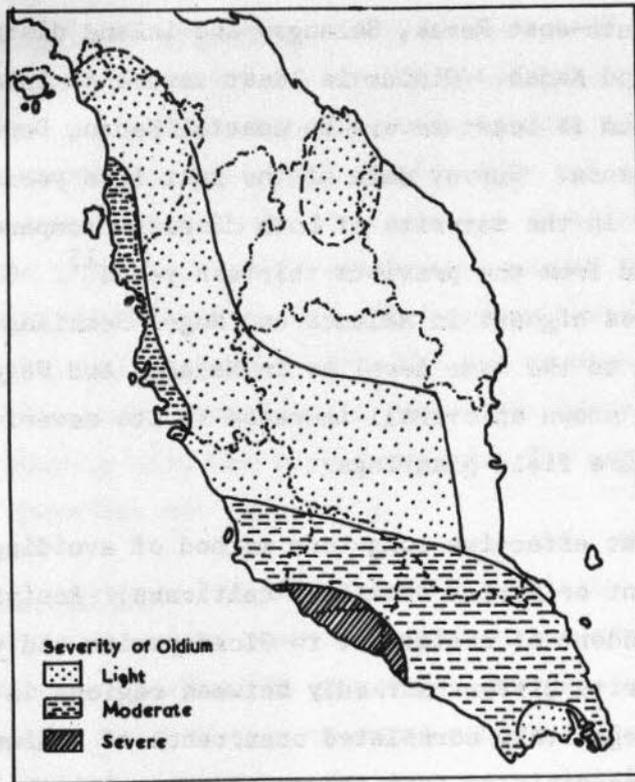


Figure 1. Occurrence and severity of Oidium leaf disease in Peninsular Malaysia.

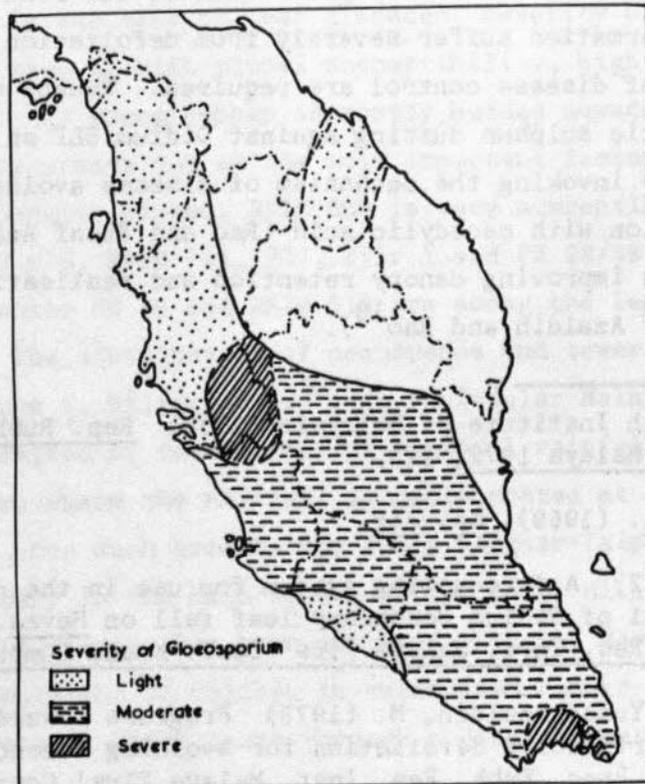


Figure 2. Occurrence and severity of Gloeosporium leaf disease in Peninsular Malaysia.

South Johore, south-east Perak, Selangor and inland districts of Negri Sembilan and Kedah. Oidium is least severe in inland Perak while Gloeosporium is least severe in coastal Kedah, Perak, Negri Sembilan and Malacca. Survey data of the last five years indicate a general increase in the severity of both diseases compared with information secured from the previous thirteen years¹⁵. Oidium incidence has remained highest in Malacca and Negri Sembilan and in Johore it has increased to the same level as in Malacca and Negri Sembilan. Gloeosporium has shown an overall increase in its severity, both in mature and immature field plantings.

The most effective long-term method of avoiding SLF is by planting resistant or partly resistant cultivars. Resistance to Oidium is independent of resistance to Gloeosporium and vice versa, and disease severity differs markedly between regions in Peninsular Malaysia. The negatively correlated occurrence of Oidium and Gloeosporium makes it possible if they tended to occur together. Their better defined distribution provides the main basis for delimiting rubber areas into various planting districts (Ho et al.¹⁶). Cultivars planted in the last ten to twenty years without the benefit of this more recent information suffer severely from defoliation and more direct methods of disease control are required. Recent work has shown prophylactic sulphur dusting against Oidium SLF on PB 5/51 (Lim, T.M.¹⁷) or invoking the mechanism of disease avoidance by aerial defoliation with cacodylic acid (Rao and Yusof Azaldin¹⁸) to be beneficial in improving canopy retention and realisation of maximum yield (Yusof Azaldin and Rao¹⁹).

¹⁵ Rubber Research Institute of Malaysia (1974) Rep. Rubb. Res. Inst. Malaya 1972, 123.

¹⁶ Ho, C.Y. et al. (1969) op. cit.

¹⁷ Lim, T.M. (1972) A forecasting system for use in the chemical control of Oidium secondary leaf fall on Hevea. Proc. Rubb. Res. Inst. Malaya Plrs' Conf. Kuala Lumpur 1972, 169.

¹⁸ Rao, B.S. and Yusof Azaldin, M. (1973) Progress towards recommending artificial defoliation for avoiding secondary leaf fall. Proc. Rubb. Res. Inst. Malaya Plrs' Conf. Kuala Lumpur 1973, 267.

¹⁹ Yusof Azaldin, M. and Rao, B.S. (1974) Economics and practicability of large-scale artificial defoliation for avoiding secondary leaf fall. Proc. Rubb. Res. Inst. Malaysia Plrs' Conf. Kuala Lumpur 1974 (in press).

Phytophthora leaf fall. Phytophthora leaf fall is confined to certain susceptible clones in the two small regions of the country which experience a prolonged monsoon - the extreme north-east during December and January and north-west during July and August (Figure 3). The degree of defoliation in mature plantings in affected areas over the eight years that the disease was present ranged from negligible to almost complete. To-date only a few hundred hectares of rubber in Peninsular Malaysia have been affected and no significant effect on yield of pre-monsoon prophylactic low-volume spraying of the fungicide, copper-in-oil, has been detected. The economics of spraying are therefore not favourable.

Pink disease. Pink disease is essentially a disease of young trees of two to eight years old and has therefore become increasingly important during the last three decades, as a result of the rapid increase of hectarage of young rubber. The disease is of considerable economic importance as it causes extensive destruction of leading branches during the wet season so that the consequent loss of canopy retards growth and extends the period of immaturity.

As in the case of leaf diseases, severity of pink disease is very much tied up with clonal susceptibility, high rainfall and the locality. As young rubber is mostly budded nowadays, clonal susceptibility stands out as the most important factor. Among the more recent popular clones, RRIM 600 is very susceptible to pink disease, RRIM 603, RRIM 701, 707, Tjir 1 and PB 28/59 are rather susceptible while PB 86 and RRIM 513 are among the least susceptible clones. The distribution of occurrence and severity of this disease (Figure 4, Hilton, R.N.²⁰) in Peninsular Malaysia are largely determined by the pattern of regional rainfall. It is usually severe where the rainfall is concentrated at certain times of the year; one such area is the Kuala Kangsar-Taiping-Kulim belt, which is largely in the rain shadow of the Larut Hill. Improved control of the disease has been achieved with the development of a paint-on formulation of Calixin in vulcanised rubber latex as a one-shot treatment which lasts through a disease season (Wastie

²⁰Hilton, R.N. (1958) Pink disease of Hevea caused by Corticium salmonicolor Berk et Br. J. Rubb. Res. Inst. Malaya, 15(5), 275.

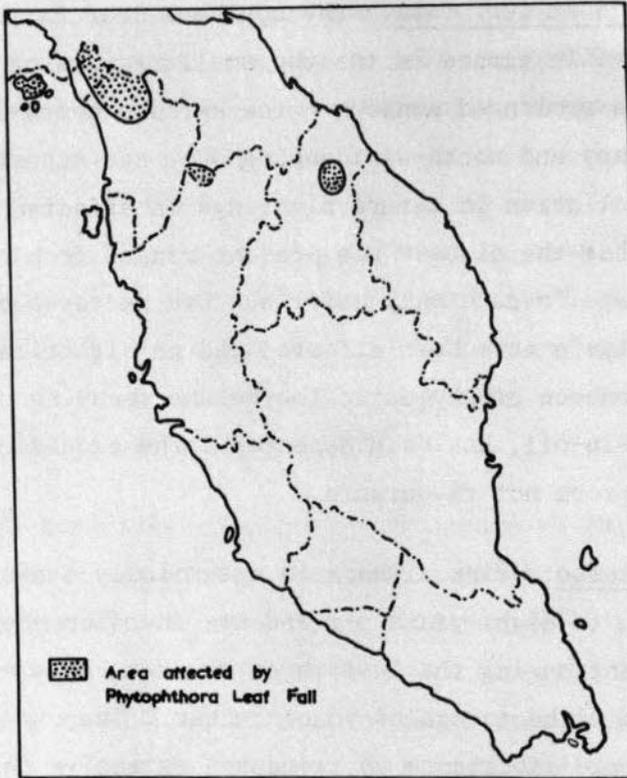


Figure 3. Occurrence of Phytophthora leaf fall in Peninsular Malaysia.

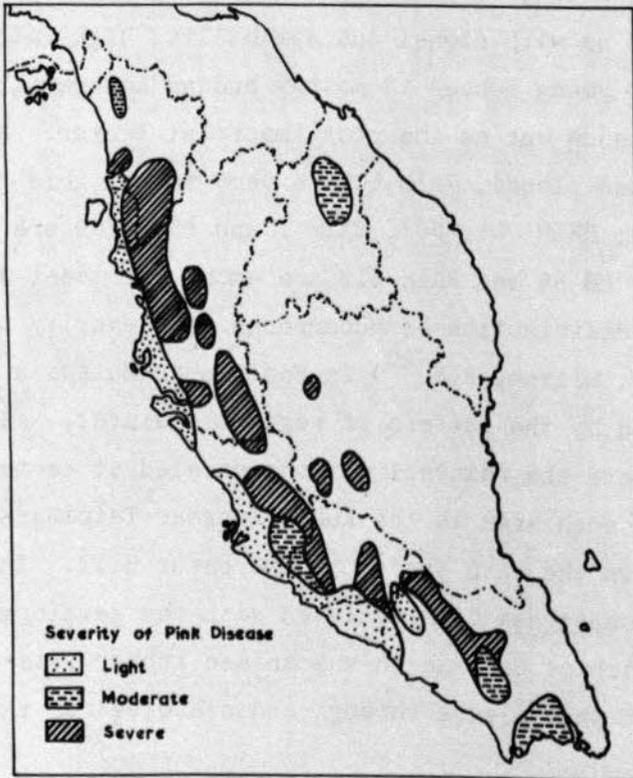


Figure 4. Occurrence and severity of pink disease in Peninsular Malaysia.

and Yeoh²¹). Having to climb an infected tree to apply the fungicide formulation somewhat limits its wider use, this being felt most in severe disease situations where timely and quick coverage of extensive hectareage of highly infected stands are required.

Discussion. The changing aspects of leaf and panel diseases of rubber in Peninsular Malaysia noticed in recent years have brought some diseases into greater prominence than hitherto. Their damaging effects, however, are obvious only on certain highly susceptible clones especially in areas where the local climate is conducive to the disease. On this basis the country has been divided into seventeen disease zones so that recommendations of the use of specific clones suitable for each zone can be made. From the point of view of disease avoidance this approach holds the best promise for the future to reduce the incidence of diseases of rubber in Malaysia to an economically insignificant level.

Influence of Soils on Yields

Yield patterns of popular clones on common soils. Soils under Hevea in Peninsular Malaysia are found to vary considerably in their physical and nutrient characteristics^{22,23} and they influence the performance of Hevea²⁴. In view of this, Chan and Pushparajah²⁵ made an assessment of the effects of such soil variations on Hevea performance to evaluate the productivity potentials of commonly planted clones on widely occurring Hevea soils in Peninsular Malaysia.

²¹Wastie, R.L. and Yeoh, C.S. (1972) New fungicides and formulations for controlling pink disease. Proc. Rubb. Res. Inst. Malaya Plrs' Conf. Kuala Lumpur 1972, 163.

²²Rubber Research Institute of Malaya (1971) Performance of clones in commercial practice: seventh report. Plrs' Bull. Rubb. Res. Inst. Malaya, No.117, 302.

²³Rubber Research Institute of Malaya (1971) Some physical factors of soils. Plrs' Bull. Rubb. Res. Inst. Malaya, No.115, 220.

²⁴Chan, H.Y., Pushparajah, E. and Sivanadyan, K. (1972) The influence of soil morphology and physiography on performance of Hevea. Proc. 2nd ASEAN Soils Conf. Bogor 1972 (in press).

²⁵Chan, H.Y. and Pushparajah, E. (1972) Productivity potentials of Hevea on West Malaysian soils: a preliminary assessment. Proc. Rubb. Res. Inst. Malaya Plrs' Conf. Kuala Lumpur 1972, 97.

They showed that a broad pattern of yield behaviour is evident for the range of different soils (Table 4). Higher yield trends on Panels A and B are observed on soils like Munchong and Rengam series which have very good physical properties compared to very low yields on Selangor and Batu Anam series soils which have poor physical properties despite having relatively high levels of nutrient contents. Physical and chemical characteristics of Holyrood and Serdang series soils are intermediate like the yields obtained on these soils. The mean yield per year is 1446 kg per hectare on Panel A (second to fifth year) for an older popular clone, PR 107 on Munchong series soil, while corresponding yields of 1185 kg, 1098 kg and 895 kg per hectare are obtained on Jerangau, Serdang and Selangor series soils respectively (Table 4). A similar yield pattern is observed for the more modern clone, RRIM 600 which on Munchong series give the highest mean yield (1736 kg per hectare), followed by Holyrood series (1290 kg per hectare), Rengam series (1248 kg per hectare) and Selangor series (897 kg per hectare).

According to Chan and Pushparajah²⁶, where the soils are ranked for the other popular clones like GT 1, PB 5/51, etc., the highest yields are obtained on Munchong series soil and the lowest yields on Selangor series soil while intermediate yields are obtained on Rengam/Jerangau series and Serdang/Holyrood series soils. Even for much older clones like PB 86 and Tjir 1 where the yields are much lower than for the modern clones, the soil ranking pattern is generally the same.

Data on Panel B yields are limited but analysis of the available data on clones PR 107, PB 86 and Tjir 1, shows a pattern similar to that obtained on Panel A; viz. highest yields are obtained on Munchong series, followed by Serdang, Jerangau, Rengam and Selangor series²⁷. Yields of PR 107, PB 86 and Tjir 1 obtained on Malacca series in particular are found to be variable and this is attributable to variation in the soil depth above the hard iron pan layer - a common property of this soil series. The hard iron pan layer is the probable cause of poor tap root formation and hence

²⁶Chan, H.Y. and Pushparajah, E. (1972) Ibid.

²⁷Chan, H.Y. and Pushparajah, E. (1972) Ibid.

TABLE 4
SOIL RANKING BY MEAN YIELD (KG/HA/YR) ON PANEL A

Yield level (kg/ha/year)	Clones and mean yield (kg/ha/year)				
	RRIM 600	GT 1	PR 107	PB 5/51	
1 500	Munchong - 1 736	-	-	-	
1 351 - 1 500	-	Munchong - 1 452	Munchong - 1 446	-	
1 251 - 1 350	Holyrood - 1 290	Rengam - 1 349	-	Munchong - 1 270	
1 001 - 1 250	Rengam - 1 246	Malacca - 1 214	Rengam - 1 185	Rengam - 1 234	
		Serdang - 1 119	Serdang - 1 098	Malacca - 1 157	
		Holyrood - 1 102		Serdang - 1 136	
800 - 1 000	Selangor - 897	Selangor - 984	Selangor - 895	Holyrood - 1 125	Selangor - 872

After Chan and Pushparajah (1972).

weak anchorage of the tree. A study by Chan and Pushparajah²⁸ (Table 5) shows that percentage tree losses by uprooting on such soils are as much as 12.7% for RRIM 600, 12.0% for PR 107, 6.0% for GT 1 but only 1.3% for PB 5/51 which has a much lighter canopy. Losses due to uprooting on the deeper soils like Rengam, Jerangau and Munchong series are negligible. These deep soils have good physical properties which sustain good root anchorage and development of the main and tap roots. Such effects would therefore influence yield obtained on soils like Malacca series (with a hard iron pan) or other shallow soils like Batu Anam series (with hard quartz vein). In flat coastal plains, a high water-table (e.g. Selangor series) can also inhibit good root anchorage and thus contribute to uprooting.

TABLE 5
YIELD OF PR 107 IN RELATION TO CLIMATE AND SOIL

Region	Rainfall (cm/year)	Soil series	Mean yield (kg/ha/year) for 2nd to 10th year
Johore	212	Rengam	1 392
Selangor	240	Rengam	1 467
Selangor	240	Selangor	1 207

Climatic influence on yields. The variable yield patterns were also traced mainly to soil variations and found to be not very dependent on climatic variations such as rainfall: the difference in yield due to rainfall was about 75 kg per hectare per year while that due to soil was 260 kg per hectare per year (Table 6)²⁹.

Clonal recommendation by soil series. Based on detailed investigations of soil rankings by yield trends presented in Table 4 and their interpolation with soil physical and chemical properties, a 'First Approximation' productivity classification of soils for

²⁸ Chan, H.Y. and Pushparajah, E. (1972) Ibid.

²⁹ Chan, H.Y. and Pushparajah, E. (1972) Ibid.

TABLE 6
COMPARISON OF TREE DAMAGE BY WIND OF POPULAR CLONES ON COMMON RUBBER-GROWING SOILS IN PENINSULAR MALAYSIA

Soil series/ association	Clones 'more prone' to wind damage (RRIM 501, RRIM 605, RRIM 623, Tjir 1, PB 86)			Clones 'less prone' to wind damage (GT 1, PB 5/51, PR 107, RRIM 600)				
	Nature of tree damaged by wind (mean %) ^a			Nature of tree damaged by wind (mean %) ^a				
	Branch breakage	Trunk snap	Uprooting	Leaning and bending	Branch breakage	Trunk snap	Uprooting	Leaning and bending
Deep soils:								
Munchong/Prang	6.3	5.1	-	1.5	2.6	1.0	-	-
Rengam	5.0	3.8	-	15.0	3.0	1.6	-	7.0
Jerangau	10.0	2.5	-	-	-	-	-	-
Shallow soils:								
Batu Anam/Durian	-	1.7	3.0	-	-	1.3	-	-
Soils with hard, usually impenetrable, ironstone, or laterite layer:								
Malacca/Gajah Mati	3.3	2.7	7.3	-	2.0	-	12.0	12.7

^a Mean figures obtained from a sample population of a maximum of thirty trees and fifty sites for each soil series. For uprooting sites, areas affected by root disease were omitted. Dashes denote nil or less than 1%.

Hevea was computed (Table 7)³⁰.

Clonal adaptability to soils. Further detailed investigations of the yield trends in Table 4 also reflect that on Munchong series soil, the mean yields on Panel A are 1736 kg, 1452 kg, 1446 kg, 1281 kg and 1270 kg per hectare for RRIM 600, GT 1, PR 107, RRIM 623 and PB 5/51 respectively. On the other hand, the 'adaptability' ranking of clones for Rengam series shows that for GT 1 the yield is 1349 kg per hectare which is 100 kg per hectare more than that for RRIM 600. For the rest of the clones, the descending order of performance is PB 5/51, RRIM 605, RRIM 623, PR 107, PB 86 and Tjir 1.

Choice of clones in relation to soil series. On the basis of such clone rankings by yields on soil series, a 'First Approximation' order of priority of Class I clones for large-scale planting has also been computed and included in Table 7.

Shorter Immaturity and Early Yields

Two important factors which affect the maximisation of return to investment in rubber planting are:

- o The period of immaturity.
- o The nature of yield profile.

The beneficial effects of a shorter immature period and maximisation of early yields have been amply demonstrated by Barlow and Ng³¹ and Lim *et al.*³². The techniques currently available for reducing the immature period have also been fully reported elsewhere³³. It is, however, necessary to reiterate the results of the analysis made by

³⁰ Chan, H.Y. and Pushparajah, E. (1972) Ibid.

³¹ Barlow, C. and Ng, S.C. (1966) Budgeting on the merits of a shorter immature period. Plrs' Bull. Rubb. Res. Inst. Malaya, No.87, 216.

³² Lim, S.C., Ho, C.Y. and Yoon, P.K. (1973) Economics of maximising early yields and shorter immaturity. Proc. Rubb. Res. Inst. Malaya Plrs' Conf. Kuala Lumpur 1973, 1.

³³ Rubber Research Institute of Malaysia (1974) Reduction of Immature Period of Rubber. Kuala Lumpur: The Rubber Research Institute of Malaysia.

TABLE 7
SOIL PRODUCTIVITY RATINGS AND RECOMMENDED ORDER OF PRIORITY OF CLASS I CLONES ON THE COMMON WEST MALAYSIAN RUBBER-GROWING SOILS
(^a'First Approximation')

Yield categories (kg/ha)	Soil productivity classes	Soil series ^a	Recommended order of priority for Class I clones
High yielding (> 1350)	Class Ia	Munchong, Prang ^c , Kuantan ^c , Segamat	RRIM 600, GT 1, PR 107, PB 5/51
Above average yielding (1250 - 1350)	Class Ib	Rengam, Jerangau, Yong Peng ^c	GT 1, RRIM 600, PB 5/51, PR 107
Average yielding (1000 - 1250)	Class IIa	Klau, Harimau ^c , Bungor ^c	RRIM 600, PR 107, PB 5/51, GT 1
	Class IIb	Serdang	RRIM 600, PB 5/51, GT 1, PR 107
	Class IIc	Subang	RRIM 600, PB 5/51, GT 1, PR 107
	Class III	Holyrood, Tampoi ^c	RRIM 600, PR 107, PB 5/51, GT 1
	Class IVa	Batu Anam/Durian ^c Sogomana/Sitiawan ^c Seremban, Apek/Marang ^c Kedah ^c , Kulai ^c , Ulu Tiram ^c)	PB 5/51, GT 1, PR 107, RRIM 600
Below average to low yielding (< 1000)	Class IVb	Malacca/Gajah Mati/Tavy	GT 1, RRIM 600, PR 107, PB 5/51
	Class Va	Briah ^c , Selangor, Linau ^c	RRIM 600, PR 107, PB 5/51, GT 1
	Class Vb	Sungei Buloh	PB 5/51, GT 1, PR 107
	Class Vc	Peat ^c	

^aIt is qualified that there are soil variations like soil texture existing within a soil series. The physiography of the soil series e.g. slope and soil depth can also vary. These variations influence growth and yield (Chan *et al.*, 1972). As such, the soil series mentioned in this Table are the model or standard soil series. Further investigations of such variations on Hevea performance will provide the basis for updating and revising these recommendations to incorporate other necessary refinements. For current practice and purpose, it is sufficient if a plantation is properly soil-mapped at the series level. This is an essential pre-requisite for any initial proper management-planning.

^bBased on very limited data, not presented.

^cThese soils have been included on the basis of very limited data and their close likeness of physical and chemical properties to the ones studied.

RRIM 600, PR 107, PB 5/51

Lim *et al.*³⁴. They show that precocious clones such as PR 255 and RRIM 703 tapped at a reduced economic life of twenty years can result in a higher return to investment than using common high-yielding clones like RRIM 600 over a conventional period of thirty years. This is true because of yield maximisation at an earlier age of tapping notwithstanding the lower cumulative yield of precocious clones over the economic life.

In view of this, it is important that when selecting planting materials, it is desirable to look into the possibility of using precocious clones. Some of the precocious clones are susceptible to wind damage and diseases but these can now be overcome by crown budding (Yoon³⁵).

³⁴Lim, S.C., Ho, C.Y. and Yoon, P.K. (1973) *op. cit.*

³⁵Yoon, P.K. (1973) *Technique of crown budding*. Kuala Lumpur: The Rubber Research Institute of Malaya.

CHAPTER III

ENVIROMAX PLANTING

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Evolution of the Enviromax System of Planting Recommendations

Previous practice in planting recommendations have stressed on yield potential of clones but the availability of high-yielding clones for large-scale planting has been seriously comprised by an over-emphasis of defects in the secondary characteristics of these clones. This is because knowledge of the environment then was not sufficiently detailed to anticipate unexpected adverse interactions between these clonal defects and the environmental factors.

Recently, it became apparent that the secondary defects of the clones per se were not the limiting factors to their performance in commercial planting. Environmental factors play an important part. Recognising this, rubber-growing areas were divided into eight and subsequently seventeen broad regions which were largely based on proneness to wind damage and the major diseases^{36,37}. Chan and Pushparajah³⁸ showed that the soil exerted a considerable influence on yield within a region and they proposed that this should be an important feature to be considered when formulating planting recommendations. On this basis of regionalisation of the rubber-growing areas, planting recommendations were further improved. This represented a significant step forward. Nevertheless, shortcomings remained; the environmental factors and soil types varied even within a particular planting region. This resulted in variable yields of the recommended clones within the region.

³⁶Ho, C.Y. et al. (1969) op. cit.

³⁷Ng, A.P. et al. (1972) op. cit.

³⁸Chan, H.Y. and Pushparajah, E. (1972) op. cit.

To overcome these shortcomings, a new approach to planting recommendations is now proposed. In this new approach, a locality is characterised by the presence of adverse environmental factors. This differs from the previous method of regional planting recommendations in important areas:

- o Different environmental types or environs can exist in a given geographical region and a particular environ can be found in many geographical regions.
- o These environs can be characterised according to the severity and number of constraints present, soil type and terrain.
- o The secondary defects of the clones and the severity of the environmental factors become important considerations in clonal selection only when their adverse interactions cause a significant decrease in yield. The capacity of the soil to develop the full potential of the clones is given more emphasis.

This new approach is designated, 'Enviromax Planting Recommendations' to signify the underlying principle of maximising the yield potential of a particular locality subject to the inhibitory influence of the environmental factors. The term 'Enviromax' is introduced to denote this new approach of planting recommendations. 'Enviro' stresses the importance of the environment and 'max' emphasises yield maximisation as the main objective. The details of this new approach are given in the following sections.

Guidelines for Enviromax Planting Recommendations

Objectives. The prime objectives in current clonal recommendations are to select clones which give high, early as well as sustained yields. The selected clones should have the following characteristics:

- o High average yield over its economic life.
- o High yield during the early years of tapping.
- o Good response to yield stimulation.
- o Good response to low intensity tapping.
- o Good vigour.

The above characteristics ensure that the income or profit per unit area or per tapper will be high. They also ensure a high rate of return on investment and a short pay-back period. This economic aspect has acquired greater prominence lately because of increasing competition for the use of capital between rubber and other crops.

Constraints. The constraints that are imposed on the above priority of selection on yield performance depend on the inherent secondary deficiencies as well as the more important adverse interactions of clonal characteristics with environmental factors.

Clonal defects. The most important secondary characteristic of a clone is its susceptibility to wind damage and of lesser importance is its susceptibility to diseases. Extreme proneness to wind damage and diseases can severely restrict its usefulness. The growth habit of a clone also determines its suitability for steep terrain and the planting system to use.

Environmental factors. The yield performance of clones can be seriously curtailed by the adverse influence of environmental constraints prevailing in a particular rubber-growing region. The important environmental factors which must be considered are:

- o Extreme severity of wind force.
- o High incidence of major diseases.
- o Suitability of the type of soil.
- o Steepness of terrain.

The importance of environmental constraints makes it necessary to identify and demarcate rubber-growing regions according to their proneness to extremes of wind and high incidence of disease. Relative performance of clones varies on different soil types. Depth of soil and steepness of terrain also affect tree performance. The boundaries of the main soil groups are, therefore, also delineated.

Interactions. The inherent defects of a clone become important only when the yield performance is affected by the shortcomings. The yield of a clone with secondary defects can be seriously curtailed by adverse environmental factors which magnify the inherent weaknesses of the clone. For example, a clone that is moderately susceptible to

wind damage cannot be planted in an area where the wind force is moderate to severe; a clone that is highly susceptible to a major disease cannot be planted in an area with high incidence of the particular disease but can be planted in a low to moderate disease area. The loss in yield due to wind damage is generally greater than that due to attack by disease. As such the new approach emphasises more on wind damage than on attack by diseases.

The suitability of soil type is important since the nature of the soil affects the yield potential of clones. It can sometimes reverse the yield ranking of clones. The steepness of terrain tends to accentuate the force of the wind and may also cause leaning tendencies in certain clones. It is, therefore, considered in relation to wind damage.

Characterisation of Rubber-growing Areas

The full yield potential of a clone can be realised only when it is planted in the best environment. The type of soil can develop or restrict the potential of clones while other environmental factors such as wind and proneness to the major diseases can seriously curtail that potential if they are particularly severe. To assist in the mechanics of the selection of clones that are most suited to the requirements of a particular region, the rubber-growing areas in Peninsular Malaysia are divided into significant environmental types which display the factors that act as constraints in the selection of clones. Each environment or environ is identified by a boundary and a distinctive colour or combination of colours and alphabetical codes (Figure 5).

The basis of demarcating the environ reflects the relative importance of the various constraints. For example, the severity of wind is an important factor. Thus, the present rubber-growing areas are divided into three regions, namely, the undelineated region indicating a light wind area, a green region, moderate wind and a green hatched region, severe wind. Since only high incidences of the major diseases exert a strong influence on the yield performance of clones which are highly susceptible to these diseases, it becomes important to identify only regions with high incidence of the major diseases. These are: red for high incidence of pink disease;

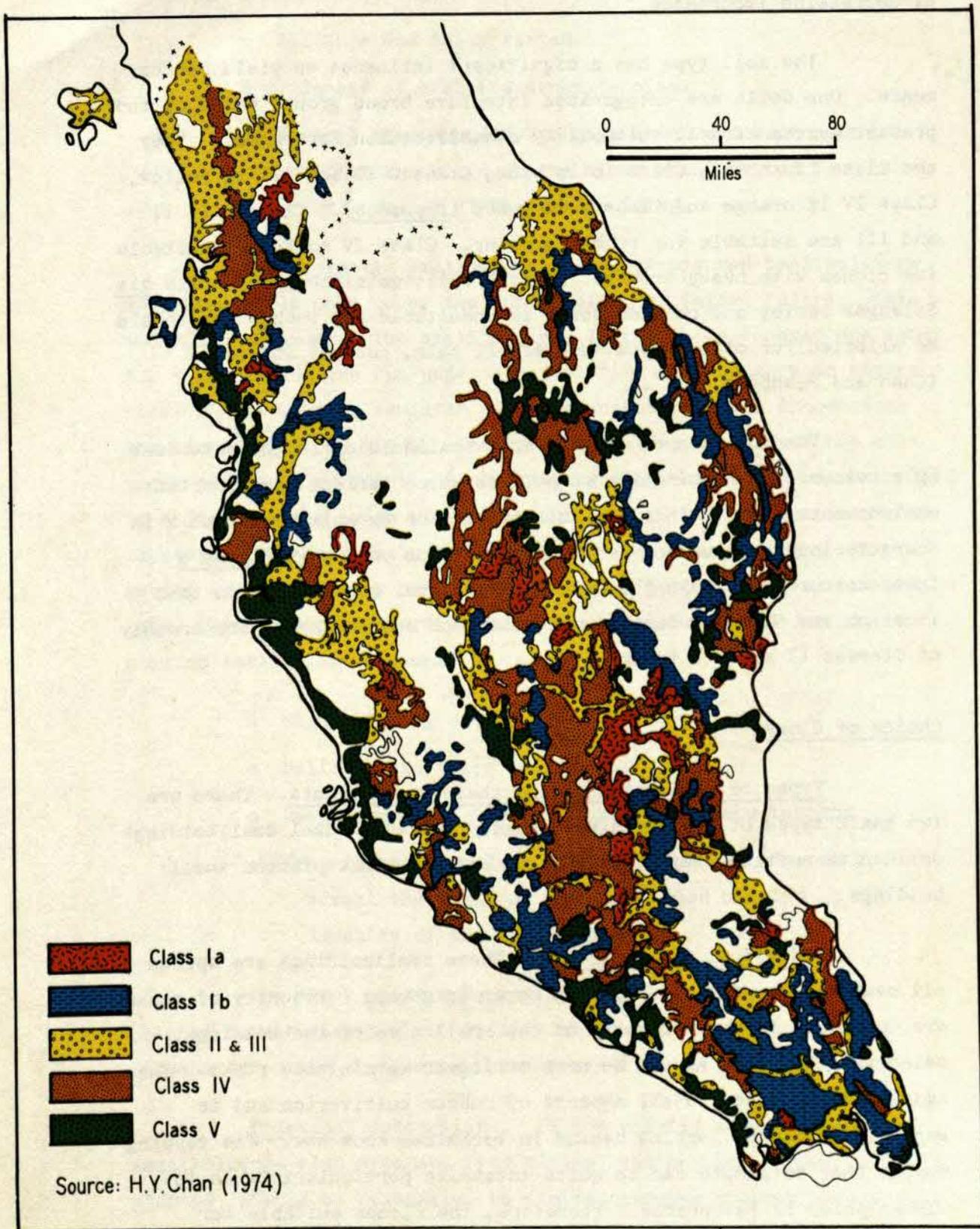


Figure 6. Reconnaissance map of soil suitability for rubber in Peninsular Malaysia.

orange for *Oidium*; blue for *Gloeosporium* and black for *Phytophthora* leaf fall. These constraints are also coded in alphabetical order of decreasing importance.

The soil type has a significant influence on yield performance. Our soils are categorised into five broad groups based on the present system of soil suitability classification for rubber. They are Class Ia in red, Class Ib in blue, Classes II and III in yellow, Class IV in orange and Class V in green (Figure 6). Classes I, II and III are suitable for rubber growing. Class IV soil is unsuitable for clones with heavy crowns. Class V soil, mainly coastal soils *viz.* Selangor series and related soil, is unsuitable for rubber and should be allotted for other crops such as oil palm, coconut and cocoa (Chan and Pushparajah)³⁹.

The location of an estate or smallholding is characterised by a colour or a combination of colours which reflect the important environmental constraints and soil type. For example, location X is characterised by blue and red in Figure 5 and yellow in Figure 6. These colours mean that the main environmental constraints in this location are *Gloeosporium* and pink diseases and the soils are broadly of Classes II and III types.

Choice of Clones

Types of smallholdings and their requirements. There are two basic types of smallholdings, namely the individual smallholdings defined as anything less than 10.1 ha and the block-planted smallholdings.

Individual smallholdings. These smallholdings are spread all over the country but normally occur in groups. Majority of these are less than 2.0 ha. Because of the small size of the holdings, selection of clones should be more stringent to minimise risks. The smallholder attends to all aspects of rubber cultivation and is generally somewhat lacking behind in technical know-how. The tapping system that he adopts can be quite intensive particularly when the rubber price is favourable. Therefore, the clones suitable for

³⁹Chan, H.Y. and Pushparajah, E. (1972) op. cit.

planting on such smallholdings should be:

- o High yielding.
- o Reliable and fully tested.
- o Tolerant of high frequency tapping.
- o Free of the secondary defects which can adversely affect the yield of the clone when planted in the locality of the smallholding.

Block-planted smallholdings. Block-planted smallholdings are those which come under the jurisdiction of Felda, Felcra, State and Fringe Schemes. The smallholdings in the above schemes are about 2.0 - 3.2 ha and are run under the direction of a manager or supervisor who is usually familiar with the recent research innovations and recommended practices. The manager decides on the various cultural practices to adopt. Since tapping frequencies can be controlled to a large extent, high yielders which respond well to low intensity tapping, e.g. third daily systems can be used to advantage. The saving in tapping time can be put to useful purpose such as running other farm enterprises. Therefore, the clones suitable for block-planted smallholdings should be:

- o High yielding.
- o Reliable and fully tested.
- o Responsive to S/2.d/2 or lower frequency tapping.
- o Free of the secondary defects which can adversely affect the yield of the clone when planted in the locality of the block planting.

For block plantings, a wide range of clones should be planted to minimise the possibility of a large-scale outbreak of disease and other unexpected calamities.

Practical constraints. Clones planted in particular smallholdings with separate land titles, whether individual or block planted, should be responsive to similar tapping systems. This will facilitate the organisation of the tapping schedule on the smallholding. This requirement is unnecessary in block plantings which are run as estates and the smallholder is paid a wage.

To accommodate unexpected changes in tapping recommendations, a clone should be planted in an area not smaller than the task size. In practice, the task size may vary from 0.8 ha to 1.6 ha depending on availability of family labour.

The logistics of supply of planting materials to the smallholdings limit the number of clones supplied to a particular smallholding. On the other hand, the smallholder should be supplied with enough varieties:

- o To minimise the risk and impact of any error in the selection process.
- o To optimise the yield profile on the holding to commensurate with the risk taken.
- o To insure against unforeseen changes in the environmental conditions of the locality.

A practical compromise to meet the above objectives and constraints should follow three guidelines:

- o No clone should be planted on an area of less than 0.8 ha and individual smallholdings smaller than 1.6 ha may be planted with only one clone.
- o A clone should not be planted on more than 50% of the planted hectareage on individual smallholdings bigger than 1.6 ha, or more than 25% of the total block planting hectareage unless the environmental constraints severely restrict the number of usable clones.
- o A Class II clone, in addition, should not be planted on more than 10% of the area under block planting.

Clones for smallholdings. Only Class I and selected Class II clones are recommended for smallholdings. Clones currently recommended are:

For individual smallholdings

Class I - GT 1, PB 5/51, PR 107, 255, 261, RRIM 600

Class II - AVROS 2037, RRIM 703

For block plantings

Class I - GT 1, PB 5/51, PR 107, 255, 261, RRIM 600

Class II - AVROS 2037, RRIM 703, PB 28/59, 235, 252,
RRIM 527

Class I clones refer to materials suitable for planting on a wide scale with or without qualifications. Performance of materials in this category has usually been confirmed by records from commercial areas.

Class II clones are promising materials that are generally not as fully tested as Class I clones. The element of risk involved in the use of these materials can, however, be reduced by localised recommendations.

The yield and main characteristics of the clones recommended for smallholdings are given in Tables 8 and 9. Table 10 highlights the major defects of the clones; these defects are colour coded so as to facilitate the mechanics of selection of clones for a particular planting region. The suitability of the clones for steep terrain or close planting is also indicated.

The recommended clones are ranked according to their yield performance on the four broad groups of soil in Table 11.

Information on the yield of PR 255 and 261 and the Class II clones on these soils is lacking and, therefore, their rankings are provisional. Clones PR 255 and 261 resemble closely RRIM 600 in habit and yield level and are, therefore, provisionally ranked after it. The other Class II clones are ranked on their yield performance in clonal trials. Clones with heavy crowns have been omitted from the Class IV soils.

A high ranking clone should always be chosen before a lower ranking clone subject to the constraints summarised in Table 10 and discussed earlier.

Selection of clones for a smallholding. The method of selection discussed here enables the choice of clones for a smallholding to be made easily. It involves three main steps:

TABLE 8
MEAN YIELD (KG/HA/YEAR) OF SOME RECOMMENDED CLONES IN LARGE-SCALE CLONE TRIALS

Clones	Year of tapping									
	1	2	3	4	5	6	7	8	9	10
<u>Class I</u>										
GT 1	700	1 180	1 410	1 640	1 570	1 960	2 280	2 340	2 310	1 880
PB 5/51	800	1 090	1 430	1 610	1 510	1 690	1 660	1 710	1 680	1 770
PR 107	540	850	1 150	1 390	1 440	1 360	1 620	1 870	1 910	1 970
PR 255	1 170	1 500	1 850	2 250	1 920	2 070	2 300	2 140	2 110	2 040
PR 261	860	1 290	1 610	1 840	1 830	2 240	2 360	2 420	2 260	2 200
RRIM 600	720	1 210	1 600	1 860	2 310	2 320	2 350	2 470	2 700	2 360
<u>Class II</u>										
AVROS 2037	440	730	1 170	1 760	1 770	1 680	1 970	2 090	2 220	2 180
PB 28/59	770	1 450	2 110	2 220	2 350	2 570	2 120	-	-	-
PB 235	1 370	1 870	2 120	-	-	-	-	-	-	-
PB 252	860	1 290	1 480	-	-	-	-	-	-	-
RRIM 527	630	1 100	1 530	1 730	1 910	2 110	2 000	1 940	1 860	-
RRIM 703	830	1 660	2 360	2 230	2 060	2 690	3 060	-	-	-

TABLE 9
SOME IMPORTANT CHARACTERISTICS OF RECOMMENDED CLONES

Characteristic	Class I - large scale						Class II - moderate scale					
	GT 1	PB 5/51	PR 107	PR 255	PR 261	RRIM 600	AVROS 2037	PB 28/59	PB 235	PB 252	RRIM 527	RRIM 703
Initial yield	3	3	2	5	4	3	1	5	5	3	4	4-5
Subsequent yield	4	3	4	4	4-5	5	4	3	4	4	4	5
Wintering depression	4	4	4	4	4	4	3	1-2	4	4	3	2
Response to stimulation	3	3	3	5	3	5	5	3	N.A.	4	3	1
Resistance to dryness	3	2	4	3	3	4	3	1	2-3	3	2	3
Resistance to wind damage	4	5	5	3-4	4	4	4	3	4	3	4	2
Resistance to pink disease	4	2-3	2-3	4	4	1	3	2	3	2-3	2	2
Resistance to Oidium	3-4	1	3	1-2	2	4	4-5	2	2-3	4-5	3	4
Resistance to Gloeosporium	3-4	3	4	3	4	3	4-5	3	3-4	3-4	4	3
Resistance to Phytophthora	2	3	1	3	2	1	1	2	3	1	3-4	3
Vigour at opening	3	3	3	4	3	2	5	3	5	4	3	3
Girth increment during tapping	3	2	4	3	3	4	4	1	3	3	2	1
Virgin bark at opening	3	3	4	4	3	2	5	2	3	3	3	5
Renewed bark	2	2	4	4	4	4	4	4	1	3	4	5
Response to wounding	4	1-2	4	3-4	2-3	2	4-5	2	3	3	1	3
Suitability for high water-table	A	A	B	B	B	C	C	C	C	C	B	C

5 = Very good 4 = Good 3 = Average 2 = Below average 1 = Poor
A = Suitable B = Acceptable C = Unsuitable

TABLE 10.
CHARACTERISATION OF CLONES RECOMMENDED FOR SMALLHOLDINGS

Clone	Susceptibility to wind damage		Severe susceptibility to			Suitability for steep terrain (> 16°)	Suitability for close planting (> 3 m)
	Moderate	Severe	Pink Oidium	Gloeosporium	Phytophthora		
GT 1						A	B
PB 5/51			●			A	C
PR 107					◐	A	A
PR 255			●			C	C
PR 261			●			C	C
RRIM 600					◐	B	C
AVROS 2037					◐	C	C
PB 28/59		◐			◐	C	C
PB 235						A	B
PB 252		◐	●		◐	A	B
RRIM 527					◐	B	B
RRIM 703		◐			◐	C	C

A = suitable B = acceptable C = unsuitable
 Each defect is given a colour code which is the same as that appearing in Figure 5.
 Only the significant defects are shown against the recommended clones.

Step 1:

- a) Locate the holding or block planting concerned in Figure 5.
- b) Note the colour or combination of colours of this location.
- c) Strike out every clone in Table 10 that has the same colour or combination of colours characterising this location.

The clones that remain satisfy the constraints imposed by wind and disease characteristics in that location. These are then examined for their suitability to the types of soil present in that area.

Step 2:

- d) Locate the same holding or block planting in Figure 2.
- e) Note the soil classes of this location.
- f) Look at the corresponding soil classes in Table 11 and choose the clones, selected in Step 1, in order of their yield rankings.

Step 3:

- g) Look at Table 10 again to determine if the selected clones are suitable for close planting and also how to distribute them over the kinds of terrains present in that area.

It should be stressed that Figure 6 only provides a broad classification of the soils. It is useful for broad planning purposes or when it is not feasible to carry out a detailed soil survey of an individual smallholding. To refine the choice of planting materials further, a more detailed soil map of the locality is necessary.

Clones recommended for the various environs. Based on the above method of selection, the recommended clones for the various environs are given in Tables 12 and 13 for individual smallholdings and block plantings respectively.

TABLE 12

CLONES RECOMMENDED FOR INDIVIDUAL SMALLHOLDINGS IN VARIOUS ENVIRONS

Environ	Code	Clones recommended		Class II
		Class I		
Severe wind, pink and Oidium	ACD	GT 1, PR 107		AVROS 2037
Severe wind and pink	AC	GT 1, PB 5/51, PR 107, PR 255, PR 261		AVROS 2037
Severe wind and Oidium	AD	GT 1, PR 107, RRIM 600		AVROS 2037
Severe wind	A	GT 1, PB 5/51, PR 107, PR 255, PR 261, RRIM 600		AVROS 2037
Moderate wind, pink and Gloeosporium	BCE	GT 1, PB 5/51, PR 107, PR 255, PR 261		AVROS 2037
Moderate wind and pink	BC	GT 1, PB 5/51, PR 107, PR 255, PR 261		AVROS 2037
Moderate wind and Gloeosporium	BE	GT 1, PB 5/51, PR 107, PR 255, PR 261, RRIM 600		AVROS 2037
Moderate wind	B	GT 1, PB 5/51, PR 107, PR 255, PR 261, RRIM 600		AVROS 2037
Pink and Gloeosporium	CE	GT 1, PB 5/51, PR 107, PR 255, PR 261		AVROS 2037
Pink and Phytophthora	CF	GT 1, PB 5/51, PR 255, PR 261		AVROS 2037
Pink	C	GT 1, PB 5/51, PR 107, PR 255, PR 261		AVROS 2037
Oidium	D	GT 1, PR 107, RRIM 600		AVROS 2037
Gloeosporium	E	GT 1, PB 5/51, PR 107, PR 255, PR 261, RRIM 600		AVROS 2037, RRIM 703
Phytophthora	F	GT 1, PB 5/51, PR 255, PR 261		AVROS 2037, RRIM 703
Undefined districts	-	GT 1, PB 5/51, PR 107, PR 255, PR 261, RRIM 600		RRIM 703 AVROS 2037, RRIM 703

The clones recommended satisfy the constraints imposed by wind and disease characteristics in that environ. These should then be examined for their suitability for the types of soil and terrain present and then ranked accordingly.

Recommendations are the same within the following environs: B and BE; BC, BCE, C and CE; E and undefined districts. The constraints are coded in alphabetical order of decreasing severity and importance: severe wind = A; moderate wind = B; severe pink = C; severe Oidium = D; severe Gloeosporium = E. Thus, environs can be characterised according to the severity and the number of constraints present, e.g. in any given soil type, the constraints in Environ ACD > Environ AC > Environ BC.

TABLE 13

CLONES RECOMMENDED FOR BLOCK PLANTING IN VARIOUS ENVIRONS

Environ	Code	Clones recommended	
		Class I	Class II
Severe wind, pink and Oidium	ACD	GT 1, PR 107	AVROS 2037
Severe wind and pink	AC	GT 1, PB 5/51, PR 255, PR 261	AVROS 2037, PB 235
Severe wind and Oidium	AD	GT 1, PR 107, RRIM 600	AVROS 2037, RRIM 527
Severe wind	A	GT 1, PB 5/51, PR 107, PR 255, PR 261, RRIM 600	AVROS 2037, PB 235, RRIM 527
Moderate wind, pink and Gloeosporium	BCE	GT 1, PB 5/51, PR 107, PR 255, PR 261	AVROS 2037, PB 28/59, PB 235, PB 252
Moderate wind and pink	BC	GT 1, PB 5/51, PR 107, PR 255, PR 261	AVROS 2037, PB 28/59, PB 235, PB 252
Moderate wind and Gloeosporium	BE	GT 1, PB 5/51, PR 107, PR 255, PR 261, RRIM 600	AVROS 2037, PB 28/59, PB 235, PB 252, RRIM 527
Moderate wind	B	GT 1, PB 5/51, PR 107, PR 255, PR 261, RRIM 600	AVROS 2037, PB 28/59, PB 235, PB 252, RRIM 527
Pink and Gloeosporium	CE	GT 1, PB 5/51, PR 107, PR 255, PR 261	AVROS 2037, PB 28/59, PB 235, PB 252
Pink and Phytophthora	CF	GT 1, PB 5/51, PR 255, PR 261	PB 28/59, PB 235
Pink	C	GT 1, PB 5/51, PR 107, PR 255, PR 261	AVROS 2037, PB 28/59, PB 235, PB 252
Oidium	D	GT 1, PR 107, RRIM 600	AVROS 2037, PB 28/59, PB 252, RRIM 527, RRIM 703

TABLE 13
CLONES RECOMMENDED FOR BLOCK PLANTING IN VARIOUS ENVIRONS (Contd)

Environ	Code	Clones recommended	
		Class I	Class II
Gloeosporium	E	GT 1, PB 5/51, PR 107, PR 255, PR 261, RRIM 600	AVROS 2037, PB 28/59, PB 235, PB 252, RRIM 527, RRIM 703
Phytophthora	F	GT 1, PB 5/51, PR 107, PR 255, PR 261	PB 28/59, PB 235, RRIM 527, RRIM 703
Undefined districts	-	GT 1, PB 5/51, PR 107, PR 255, PR 261, RRIM 600	AVROS 2037, PB 28/59, PB 235, PB 252, RRIM 527, RRIM 703

The clones recommended satisfy the constraints imposed by wind and disease characteristics in that environ. These should then be examined for their suitability for the types of soil and terrain present and then ranked accordingly.

Recommendations are the same within the following environs: B and BE
BC, BCE, C and CE
E and undefined districts

The constraints are coded in alphabetical order of decreasing severity and importance: severe wind = A; moderate wind = B; severe pink = C; severe Oidium = D; severe Gloeosporium = E. Thus, environs can be characterised according to the severity and the number of constraints present, e.g. in any given soil type, the constraints in Environ ACD > Environ AC > Environ BC.

CHAPTER IV

PLANTING MATERIALS FOR FIELD ESTABLISHMENT

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PLANTING MATERIALS FOR FIELD ESTABLISHMENT

Types of Materials

Seeds and seedling stumps. The original method of establishment of Hevea was by seeds whereby germinated seeds were planted in the field. Seeds were germinated in the nursery to a stage where brown bark formed up to a height of about 60 centimetres. At this stage, the plant was cutback on brown bark at a height of 60 cm, it was extracted and the tap root pruned to a length of about 20 centimetres. The cut end of the stem was sealed with wax. The stumps were then used as materials for field establishment.

Brown and green budding. With the realisation of the large variation in the performance of seedling rubber, vegetative propagation of selected clonal materials was introduced. By this method, seeds were established in the field and allowed to grow for about a year, then brown budded at a height of about 10 - 15 cm from ground level and cutback.

Later Hurov⁴⁰ showed that by using a different technique of budding on green tissue with green bud patch, the budding operation could be done at an earlier stage. This technique was improved for large-scale implementation by Tinley⁴¹ who showed that by this technique clonal materials could be obtained in about six months from seed emergence.

⁴⁰Hurov, H.R. (1961) Green-bud strip budding on two- to eight-month-old rubber seedlings. Proc. nat. Rubb. Conf. Kuala Lumpur 1960, 419.

⁴¹Tinley, G.H. (1962) Propagation of Hevea by budding young seedlings. Plrs' Bull. Rubb. Res. Inst. Malaya No.62, 136.

Advanced planting material. Tinley⁴² further showed that such budded materials raised in nurseries could be transplanted in polythene bags. These could then be transplanted to the field after the plants reached the two-whorl stage.

Other approaches made at the same time were the use of budded stumps, soil-core transplanting of budded stumps or buddings at the first or second whorl stage.

Mainstone⁴³ demonstrated that budded materials could be raised in polythene bags to a stage of four whorls or a height of 90 - 120 cm and successfully transplanted to the field.

Strivens⁴⁴ used an entirely different approach viz. use of stumped buddings. These were plants which were grown to up to 18 months after budding to a girth of 10 cm or more. The tap root was then pruned but the top was pruned later at a height of 270 - 300 cm to give a clear stem with brown bark.

Shepherd⁴⁵ and Templeton⁴⁶ tested the various techniques of and materials for field establishment. Due to various setbacks, use of 'advanced planting materials' were not put to practice. However, budded stumps and to a lesser extent, mini stumps were used commercially.

Recently, Sivanadyan et al.⁴⁷ showed that with improvement in nursery and field practices 'advanced planting materials' such as

⁴²Tinley, G.H. (1962) Ibid.

⁴³Mainstone, B.J. (1962) Dunlop polythene bag planting technique. Plrs' Bull. Rubb. Res. Inst. Malaya No.63, 154.

⁴⁴Strivens, L.V. (1962) Planting stumped buddings. Plrs' Bull. Rubb. Res. Inst. Malaya No.62, 148.

⁴⁵Shepherd, R.A. (1967) Study of the comparative merits of different planting techniques. Plrs' Bull. Rubb. Res. Inst. Malaya No.92, 214.

⁴⁶Templeton, J.K. (1967) Comparison of nursery methods for budded planting materials. Plrs' Bull. Rubb. Res. Inst. Malaya No.92, 221.

⁴⁷Sivanadyan, K., Musa Mohd. Said, Woo, Y.K., Soong, N.K. and Pushparajah, E. (1973) Agronomic practices towards reducing the period of immaturity. Proc. Rubb. Res. Inst. Malaya Plrs' Conf. Kuala Lumpur 1973, 226.

large plants in polythene bags and stumped buddings could be used successfully.

In this chapter, details of the methods of raising various forms of planting materials which are shown in the flow chart (Figure 7) are considered.

To produce the clonal materials, seeds have to be obtained to generate the stocks and source-bush nurseries have to be established to produce budwood. The various aspects of seed collection, germination of seeds, production of source-bush nurseries and the preparation of clonal materials are also discussed.

Seed Collection Germination and Budding

Seed collection. A seedling stock is a pre-requisite to propagate clonal planting material of any form. This means that seeds of good seedling stocks should be readily available.

In Peninsular Malaysia, there are two seedfall seasons per year. The main seedfall occurs from late August to late September and the secondary seedfall is from early February to late March. The percentage germination of seeds from the main seedfall is about 90% and that from the secondary seedfall is only 60%. Therefore, to obtain a given number of germinated seeds, the number of seeds required from the February/March seedfall will be twice as much as from the main seedfall.

Before the seedfall, the potential collection area has to be clean-weeded and cleared of old seeds. Once the seedfall commences, seed collection has to be done once every two days.

Seed viability and storage. It must be realised that rubber seeds remain viable only for a short period, hence they should be used without much delay. If germination has to be delayed then the seeds can be stored in perforated polythene bags with damp saw-dust (with 10% moisture) or powdered charcoal (20% water by weight) for about three months if the bags are spread out and stored in a cool place. At about 4°C, they can be stored in sealed polythene bags for more than four months.

Period in
months

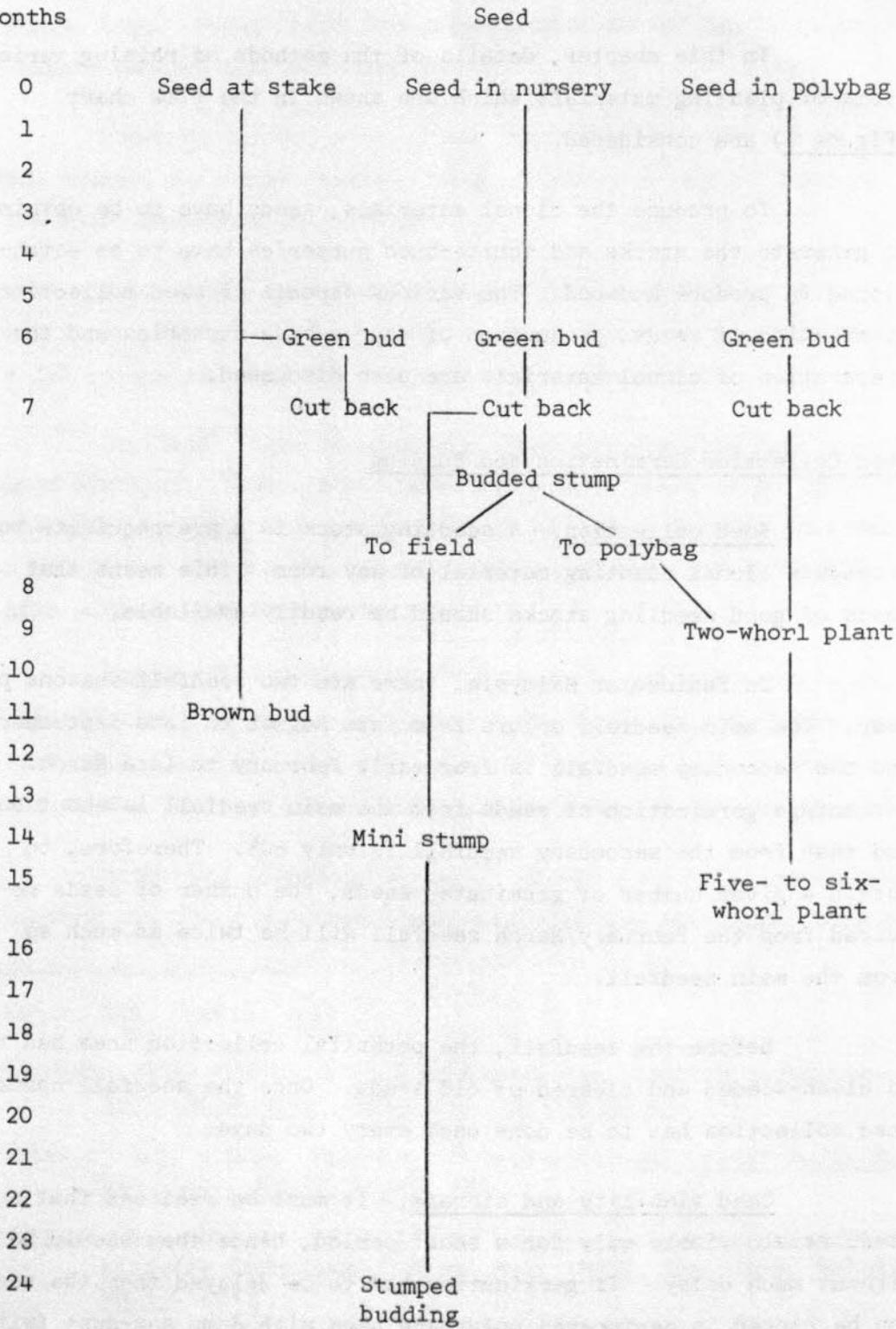


Figure 7. Planting materials for field establishment.

Germination of seeds. A germination bed (Plate 1) of about 15 cm depth is usually prepared by using river sand. The surface of this could then preferably be covered with saw-dust. A bed of 900 cm² can accommodate about 100 seeds (Plate 2). A roof of either attap, coconut leaf or hesian cloth should be erected over the bed and the height of the roof should be about 60 - 90 centimetres.

If saw-dust is not available, the seeds should be planted with about half the seeds below the surface and the bed covered with jute bags which are kept wet. The jute bags should be removed at night to prevent fungal attack on the seeds. The seed bed should be watered daily. After 10 - 14 days, the seeds begin to germinate, with peak germination occurring at about the fourteenth to twenty-first day. As soon as the radicle has emerged, the germinated seeds should be removed and planted in a nursery, polybag or field depending on the type of materials to be used for field planting.

Planting of germinated seeds. It is important to plant the germinated seeds correctly. The seed should be planted horizontally with the curved surface uppermost and the radicle (sprout end) pointing downwards. This is to facilitate good stem development and encourage the root to grow downwards into the soil. The sprout should always point downwards irrespective of whether the dorsal or ventral surface of the seed touches the ground. If this is not observed, the seedlings will give rise to twisted roots. The uppermost surface of the seeds should just be visible above the soil.

Budgrafting. The method of budding Hevea using scion from green sticks instead of the conventional brown budwood (Plate 3) scion was first reported by Hurov⁴⁸. This method of propagation has since the early sixties become popular with the industry.

The green budsticks are obtained by cutting back a growing budding in the source-bush nursery (Plate 4) thus forcing many shoots to emerge. The green buds which are found on these new shoots are used. Seedling rootstocks between two and eight months old can be grafted with these green buds.

⁴⁸Hurov, H.R. (1961) op. cit.



Plate 1. Germination beds.

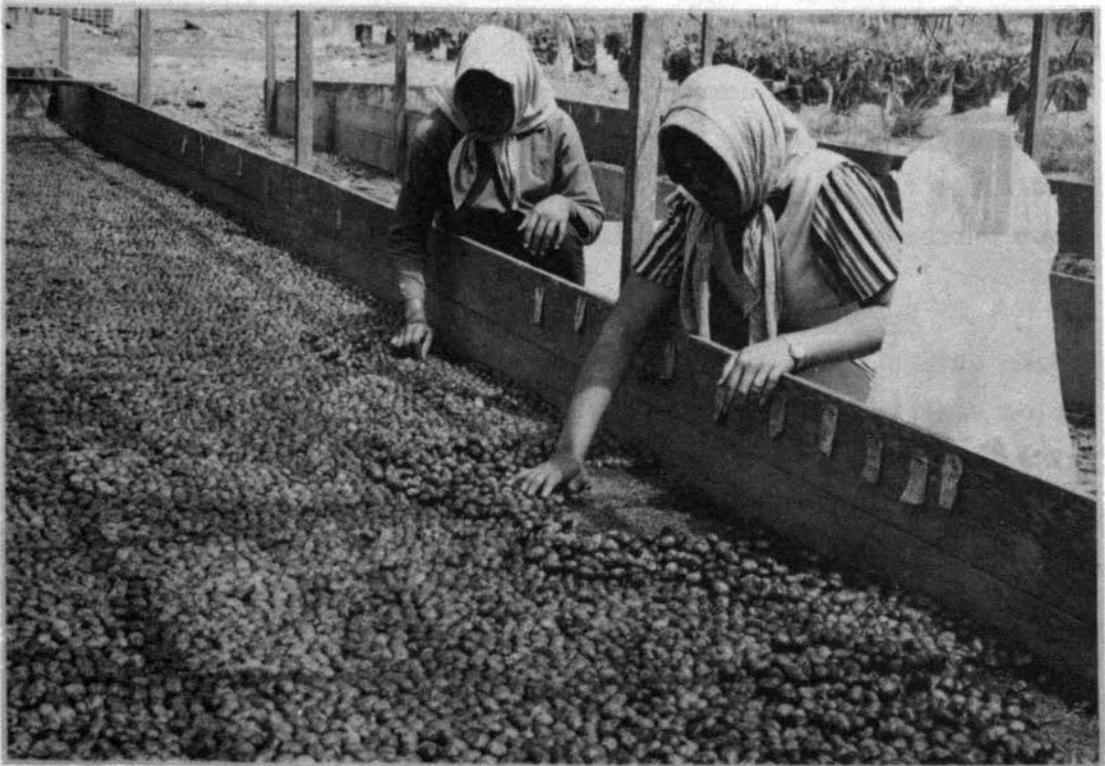


Plate 2. Seeds being placed on germination beds for germination.

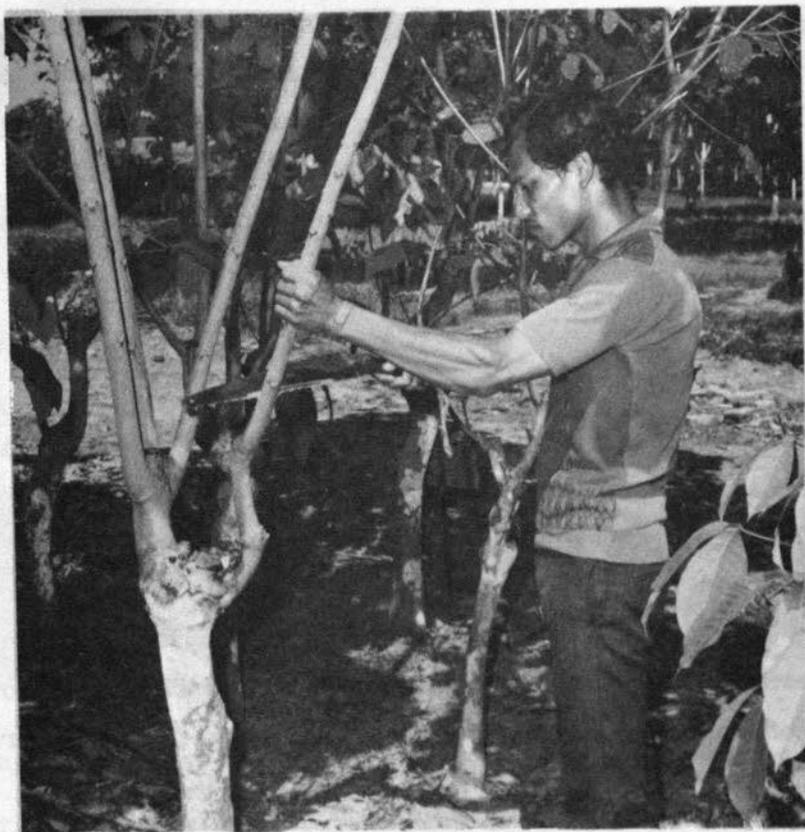


Plate 3. Brown budwood being harvested.



Plate 4. Green source-bush nursery three months after cutting back in order to obtain green budsticks.

The budding panel (Plate 5) is exposed by pulling up the strip of bark and cutting away the flap leaving about one centimetre of it. The bud-patch from which the sliver of wood has been peeled away is inserted under the flap and wound downwards with a polythene tape (Plate 6) which is tied at the end. The stocks (Plate 7) are cutback about three weeks after budding during favourable weather.

Selection of Nursery for Raising Materials

Ground nursery. The nursery should be sited on a well drained area which is free of root disease. This is often achieved by removing old stumps and siting the nursery away from mature stands. The soil should preferably be of heavy texture and good structure, e.g. friable clay or sandy clay loam soil of Munchong, Prang, Rengam or Jerangau series. The nursery must be sited to allow easy supervision and maintenance and may have to be fenced to prevent animals from damaging the plants.

Polybag nursery. All other requirements except for in situ soil type are as for ground nursery. The soil type is not of major importance but it must be free draining and on gently sloping terrain.

Preparation of Planting Points

Field planting. The planting points have to be marked out according to terrain and density required. At each planting point, a hole 60 x 60 cm should be dug and filled with loose surface soil. About 110 g of rock phosphate should be incorporated in the planting hole.

Ground nursery. The land must be ploughed to a depth of 20 cm and 625 kg per hectare of rock phosphate and 250 kg per hectare of magnesium limestone should be harrowed in. All woody remains, stumps, etc. have to be removed to eradicate the source of inoculum for root disease. The planting points as appropriate should be marked out.

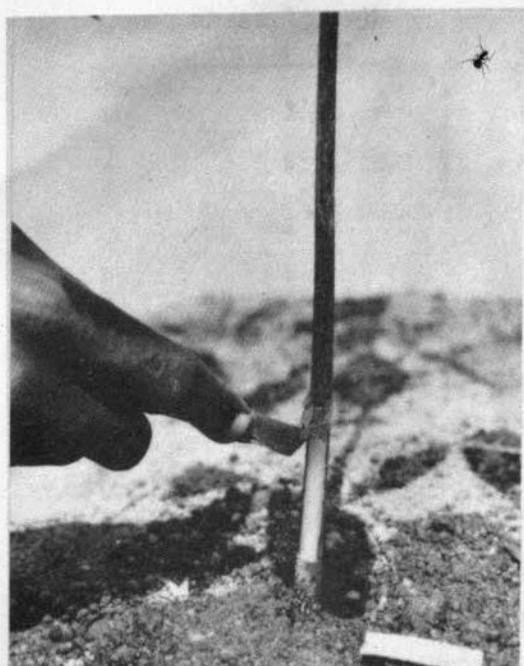


Plate 5. Budding panel exposed by pulling up the strip of bark and cutting away the flap leaving about one centimetre of it.



Plate 6. Bud-patch of the clone being grafted is inserted under the flap and wound downward with polythene tape.



Plate 7. Seedling stock with successfully grafted scion three weeks after budding.

<u>Type of nursery</u>	<u>Planting distance</u>	<u>No. of seeds per point</u>
Budded stumps	15 x 30 cm	1
	or 30 x 60 cm	2
Mini stumps	15 x 30 cm	1
	or 30 x 60 cm	2
Stumped buddings	60 x 90 cm	3
	or 90 x 90 cm	3
Source bush	120 x 120 cm	3

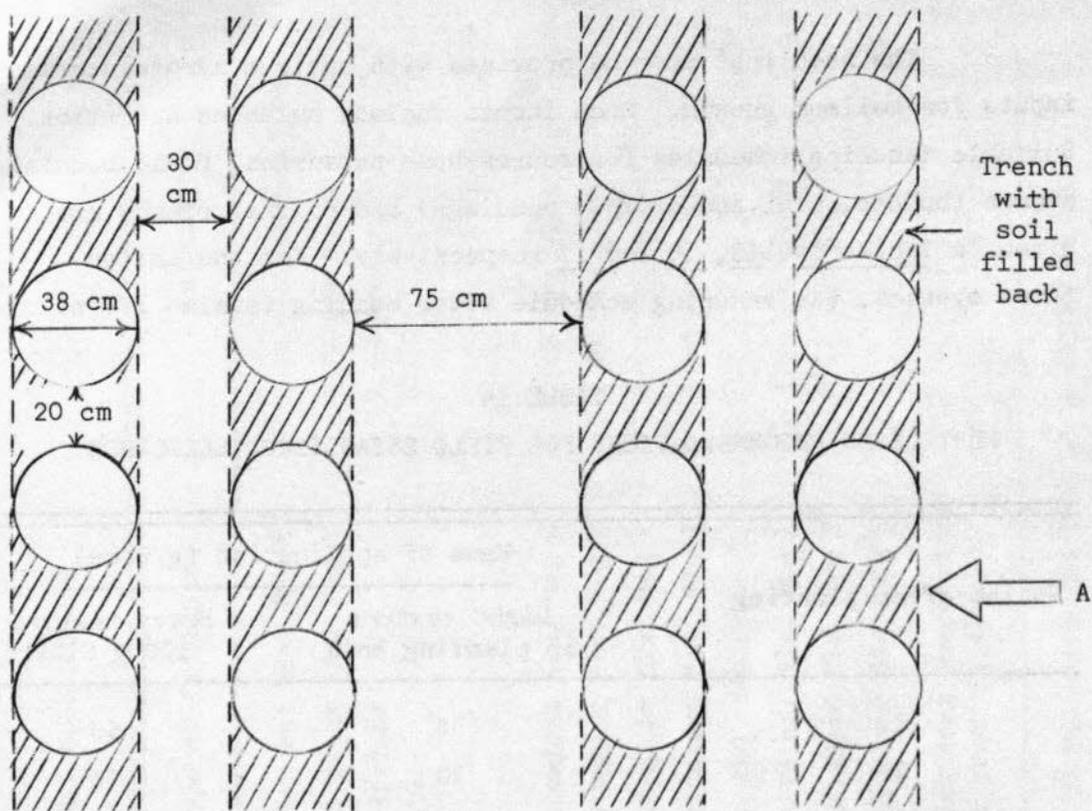
Polybag nursery. Surface soil from a good structured soil is collected after removal of surface vegetation. The soil should then be partially dried and pieces of stubble and roots removed and the larger soil clods broken into smaller pieces. The polybags are filled with soil incorporated with 56 g of rock phosphate, to about 3 cm below the brim of the bag.

<u>Material</u>	<u>Lay flat poly-bag size (cm)</u> 500 gauge	<u>Amount of soil (kg)</u>	<u>Space (cm)</u>		<u>Seeds per point</u>
			<u>Between bags</u>	<u>Between rows</u>	
2 whorl stage	25 x 56	9	15	20	1
6-7 whorl stage	38 x 64	23	20	30	2

In the nursery, the bags must be arranged so as to prevent any self shading or competition. Trenches of about 20 cm deep are made by digging out the top soil and the larger bags positioned in these trenches. The bags are anchored by mounding around the exposed portions up to 6 cm below the brim of the bags (Figure 8).

Planting of seed. The pre-germinated seeds are then planted in the field, nursery or polybags with the appropriate number of seeds per point indicated earlier. For field planting, the establishment should coincide with the onset of rainy weather, while nursery establishment can take place at any time provided irrigation is practised.

Though three seeds are planted in one point, these should be thinned down to two a month later.



View from A

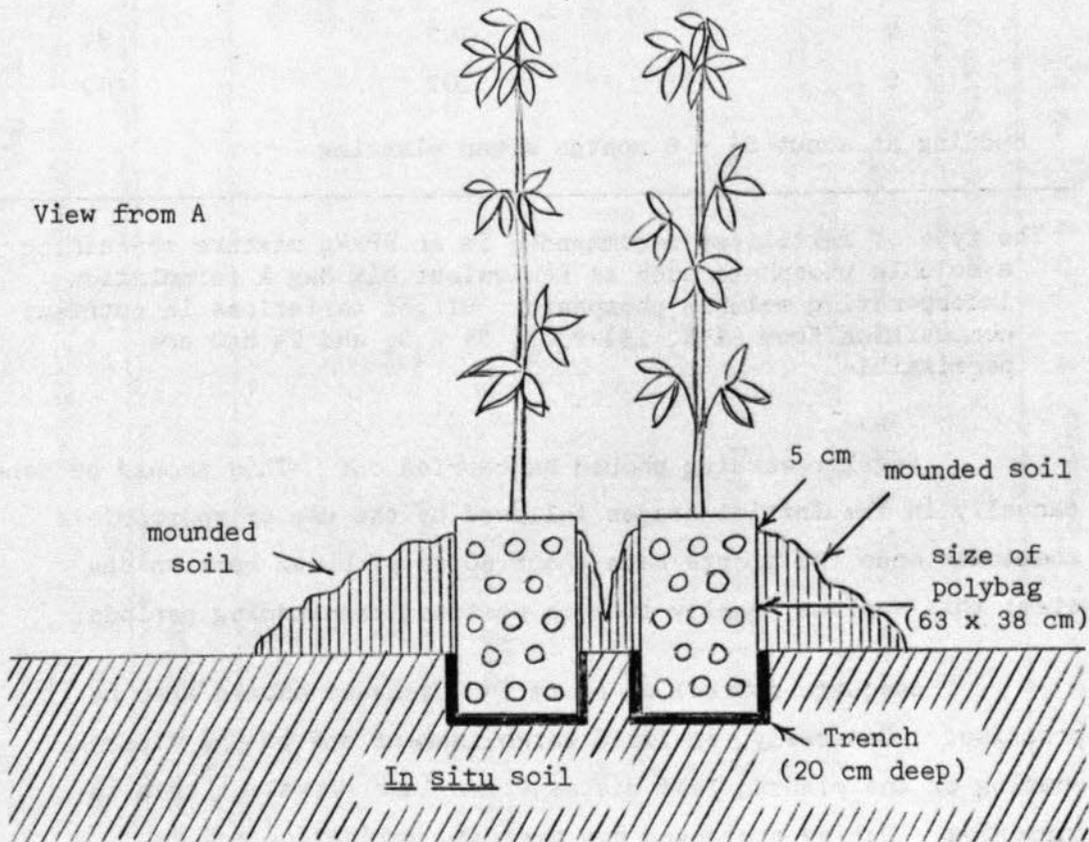


Figure 8. Placement of polybags in nursery.

Care and Maintenance of Seedlings

The seedlings must be provided with optimum agro-management inputs for maximum growth. Such inputs include balanced nutrition. Suitable manuring schedules for source-bush nurseries, field budding, stumps (budded, mini and stumped buddings) and polybag plants are given in Tables 14, 15, 16 and 17 respectively. For the latter three systems, the manuring schedule after budding is also given.

TABLE 14
FERTILISER RECOMMENDATIONS FOR FIELD ESTABLISHED SEEDLINGS

Months after planting	Rate of application (g/tree)	
	Light texture in planting hole	Heavy texture 102 g CIRP
1	56	56
2	70	56
3	84	70
4	102	84
5	102	102

Budding at about $5\frac{1}{2}$ - 6 months after planting

The type of fertiliser recommended is an NPKMg mixture containing a soluble phosphate such as Equivalent Mix Mag X formulation incorporating soluble phosphate. Slight variations in nutrient composition from 9% N, 15% P_2O_5 , 7% K_2O , and 2% MgO are permissible.

Regular weeding should be carried out. This should be done manually in the initial stages followed by the use of appropriate chemicals once the plants have about 60 cm of brown bark on the stem; this applies equally to both post and pre-budding periods.

Adequate control of pests and diseases should also be practised. Generally, in field establishment due to the wider spacing of the plants, leaf diseases are less prevalent than in nurseries. During prolonged dry periods, irrigation may be necessary.

TABLE 15
MANURING RECOMMENDATION FOR SOURCE-BUSH NURSERY

Months after planting of seeds	Type of fertiliser	Amount
2	Equivalent Mix. Mag X ^a	2 oz per running yard
3	Equivalent Mix. Mag X ^a	1 oz per point
4	NK Mixture	1 oz per point
6	Seedling budded	
<u>Months after cutback</u>		
1	Equivalent Mix. Mag X ^a	1 oz per point
3	Equivalent Mix. Mag X ^a	1 oz per point
5	Equivalent Mix. Mag X ^a	1 oz per point
7	Equivalent Mix. Mag X ^a	1 oz per point
8	Buddings pollarded	
9	Equivalent Mix. Mag X ^a	1 oz per point
12	(Harvest first crop of green sticks)	Equivalent Mix. Mag X ^a
15	(Harvest second crop of green sticks)	Equivalent Mix. Mag X ^a

Continue with same rate of manuring once every three months after each harvest of green sticks.

^aEquivalent Mixture Mag. X contains 9% N, 15% P₂O₅, 7% K₂O and 2% MgO where the P is in a soluble form. Slight variations in nutrient composition in other related fertilisers incorporating soluble P are permissible.

TABLE 16
MANURING SCHEDULE FOR BUDDED STUMP AND MINI STUMP NURSERIES

Period	Type of fertiliser	kg/ha	cwt/acre	Rate of application
<u>Before planting</u>				
	Magnesium limestone (plough in)	250	2	
	CIRP (harrow in)	625	5	
<u>Months after planting</u>		<u>g/running 90 cm</u>		<u>oz/running yard</u>
2	Equivalent Mixture Mag X ^a	56		2.0
3	Equivalent Mixture Mag X ^a	56		2.0
4	NK Mixture	56		2.0
5	Equivalent Mixture Mag X	56		2.0
A	Bud at about 6 months			
<u>Months after cutback</u>		<u>g/running 90 cm</u>		<u>oz/running yard</u>
1	Equivalent Mixture Mag X	56		2

TABLE 16
MANURING SCHEDULE FOR BUDDED STUMP AND MINI STUMP NURSERIES (Contd)

Period	Type of fertiliser	Rate of application	
Months after cutback		g/tree	
		oz/tree	
3	Equivalent Mixture Mag X	28	1.0
5	Equivalent Mixture Mag X	28	1.0
B 7	Equivalent Mixture Mag X	42	1.5
9	Mixture Mag X	42	1.5
11	Mixture Mag X	42	1.5
13	NK Mixture	42	1.5
15	Mixture Mag X	56	1.5
17	Mixture Mag X	56	2.0

Prepare for extraction of stumped buddings at about 18-20 months after cutback

^aEquivalent Mixture Mag X contains 9% N, 15% P₂O₅, 7% K₂O and 2% MgO where phosphate is in a soluble form. Slight variations in nutrient composition in other related fertilisers incorporating soluble P are permissible.

A - Schedule for budded stumps ends here; B - Schedule for mini stumps ends here.

Caution: During the initial eight months after planting, do not use fertilisers containing nitrate nitrogen.

TABLE 17
MANURING SCHEDULE FOR POLYBAG PLANTS

Time after planting seed in polybag (months)	Dosage rate of fertiliser ^a gm/bag (oz)
<u>At planting</u>	56 g or 2 oz of CIRP
1	7 ($\frac{1}{4}$)
2	14 ($\frac{1}{2}$)
3	14 ($\frac{1}{2}$)
4	22 ($\frac{3}{4}$)
5	22 ($\frac{3}{4}$)
A	
	Budding
<u>Time after cutback (months)</u>	
1	14 ($\frac{1}{2}$)
2	22 ($\frac{3}{4}$)
3	28 (1)
4	28 (1)
5	28 (1)
6	28 (1)
7	42 ($1\frac{1}{2}$)
8	42 ($1\frac{1}{2}$)
9	42 ($1\frac{1}{2}$)

^aFertiliser incorporating a soluble phosphate with composition equivalent to Mix. Mag X or other formulations with slight deviation from Mix. Mag X but with soluble P are permissible.

A - Schedule for small polybags ends here.

Control of Diseases and Pests in Nurseries

Root diseases. Root diseases are seldom encountered in nurseries if choice of the site has been carefully made. Infection sources in old jungle stumps, rubber or other cultivated trees are easily excluded. Where these are present, the area should be ploughed and fully cultivated followed by root collection before the seeds are sown. When root diseases appear in the nurseries, frequently white root disease, their spread among the closely planted stand can be rapid and the damage extensive. The affected patch can be noticed easily by dead or dying plant or diseased roots. Complete removal of the diseased plants followed by tracing and eradication, or effective isolation of the infection sources will prevent rapid increase of casualties. At the time of planting, the root system of the plant must be inspected for symptoms of root infections. Any plant with its tap root diseased should be discarded and any diseased laterals surgically removed.

Leaf diseases. While in the nursery, young seedlings are particularly prone to attack by Bird's eye spot which produces typical lesions on young leaves. To protect young flushes which emerge periodically, 6 - 8 weekly rounds of spraying with 0.2% Zineb during the rainy period are required. Anthracnose leaf disease can be largely overcome by improving the drainage or the addition of supplementary doses of fertilisers to the soil in the affected parts of the nursery.

Frequent outbreaks of either *Gloeosporium* or *Oidium* (mildew) occur in crowded and moist nurseries especially in districts where *Gloeosporium* or *Oidium* SLF is endemically severe. *Gloeosporium* infects young emerging buds, particularly during the wet seasons, causing extensive damage to leaves or complete defoliation. A regular weekly spray of 0.2% Calixin will effectively control the mildew.

Stem diseases. Though pink disease is not a problem in nurseries, mild cases may occasionally be encountered during exceptionally prolonged wet spells in disease-prone areas. It attacks the brown stem of older buddings. A single application of 2% Calixin in latex concentrate to the affected parts will eliminate the disease.

Root-feeding insects. Termites are widely distributed in jungle and cultivated areas. An occasional attack in nurseries can be controlled by drenching the soil around all plants in infested patches with Aldrex 2 or Heptachlor 2E both diluted at 2.5 ml in 1:1 water (2 oz in 5 gal water). Sometimes severe loss of plants occurs in nurseries established on partially cleared land in cockchafer-infested areas. The same insecticides but at double the concentration are effective against cockchafer grubs.

Above-ground pests. Under crowded nursery conditions, severe flare-up of mites and thrips can occur, causing defoliation of tender flushes and growth stagnation. They can be controlled by spraying Dieldrex 15 diluted at 3 ml 1:1 water (1 oz in 2 gal water) or Thiodan 35 diluted at 1.5 ml in 1:1 water (2 oz in 9 gal water). Repeated applications for five days should effectively eliminate these pests from the plants. Scale insects and mealy bugs can also be destructive, causing defoliation and dieback. They can be controlled by spraying with 2.5% kerosene-soap emulsion (1 pint kerosene 1 lb soap, 5 gal water). One or two applications at weekly intervals may be necessary to eradicate the pests.

Preparation and Care of Planting Materials

Green budsticks (Plate 8). When the buddings in the nursery have grown to about the fourth or fifth whorl stage and have brown wood of about 120 - 150 cm, the plants are pollarded at a height of about 90 cm from the ground; the pollarding should be done just above a whorl of dormant buds. On vigorous plants eight to ten shoots would emerge in about a fortnight. These should be selectively pruned to leave about four to five vigorous shoots. By about six to eight weeks from pollarding, the leaves of the new shoots would be mature. However, in normal commercial practice, the shoots are allowed to remain for up to three months from pollarding to obtain green-brown budsticks. By the third harvest, each bush should give eight sticks.

The shoot is severed just above a whorl of dormant buds (Plate 9). The buds left behind would form the new shoots. The harvested shoots are then prepared by first cutting off the flush of leaves giving a budstick with at least two dormant buds.

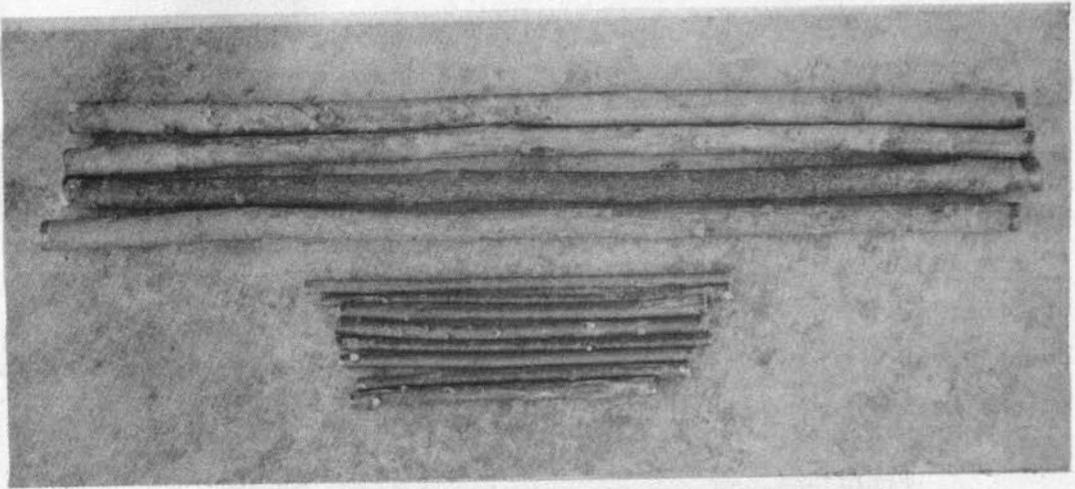


Plate 8. Comparison of brown budwood (large poles) with green and green-brown budsticks (small sticks).

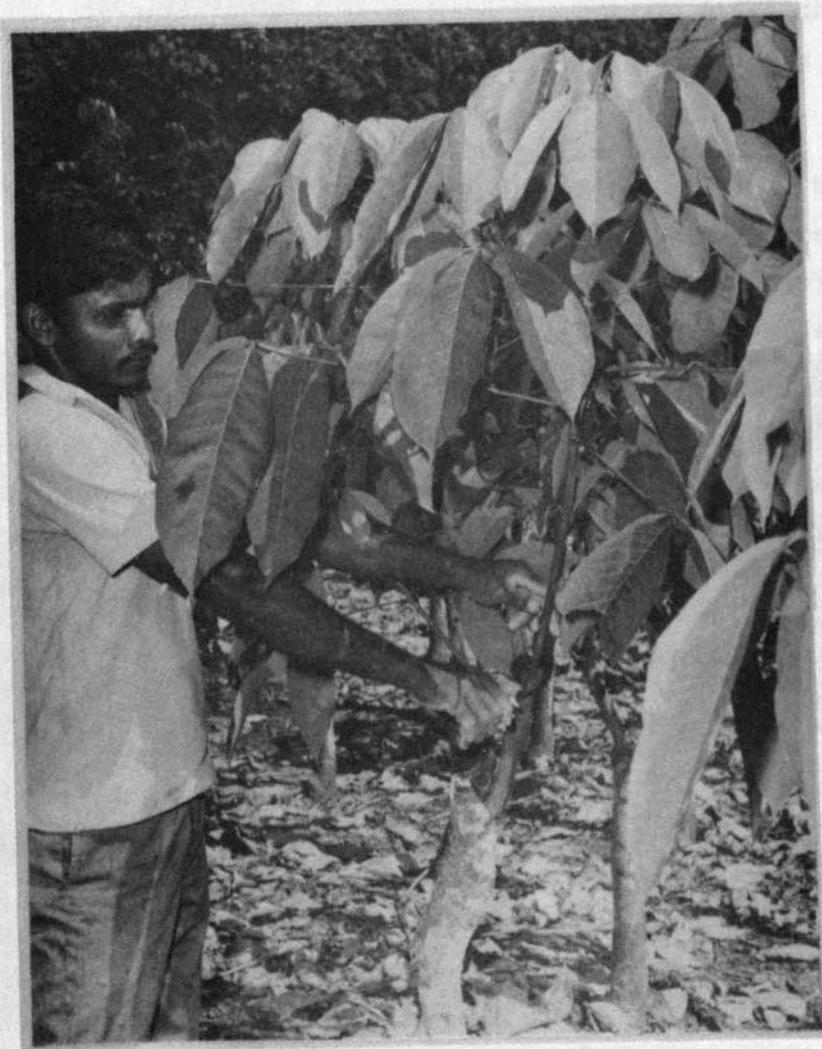


Plate 9. Harvesting of green budsticks.

The budsticks can be carried in a polythene bag if they are to be used on the same day and in the same area as the source. They should not be unduly exposed to the sun. If the budsticks are to be despatched to another place, the cut ends of the sticks should be waxed (Plate 10). The sticks should then be packed (Plate 11) in a cardboard box in layers with about 1 cm of sawdust or other suitable packing materials in between each layer. The boxes have to be stored in a cool place. If care is taken, the budsticks packed thus can keep for up to six days.

Field established seeds. Once budded and cutback, the bud-patch on the rootstock becomes the clonal material (Plate 12).

Materials established in ground nurseries. Seeds established in field nurseries can be converted to three forms viz. budded stumps, mini stumps and stumped buddings.

Budded stumps. Budded stumps (Plate 13) are materials obtained immediately after cutback of the seedling stock; the cutback being made at a height of 6 - 10 cm above the bud-patch at about a month after budding. The material is extracted from the ground by first severing the tap root at a length of 20 - 30 cm from the surface. This material viz., the stump, becomes the planting material. The budded stumps should be transplanted within two days of extraction. Care should be taken to avoid exposure to sun or damage to buds.

The budded stumps can also be planted in polybags (Plate 15) and raised to five- or six-whorl stage plants.

In budded stumps, often the dormant buds from the stock tend to sprout. This will suppress the development of the bud from the bud-patch. As such, all shoots sprouting from the stock should be pruned off to allow development of the bud from the bud-patch.

Mini stumps. Mini stumps (Plate 16) are obtained by allowing the bud to develop into a scion (Plate 17) to a stage where about 60 cm of brown bark is obtained on the base of the scion. The tap root need not be 'tailed' in the case of mini stumps. The shoot above the brown bark is cut off just above a whorl of dormant buds about ten days before extraction. The cut-end of the budding is



Plate 10. Budsticks being waxed.

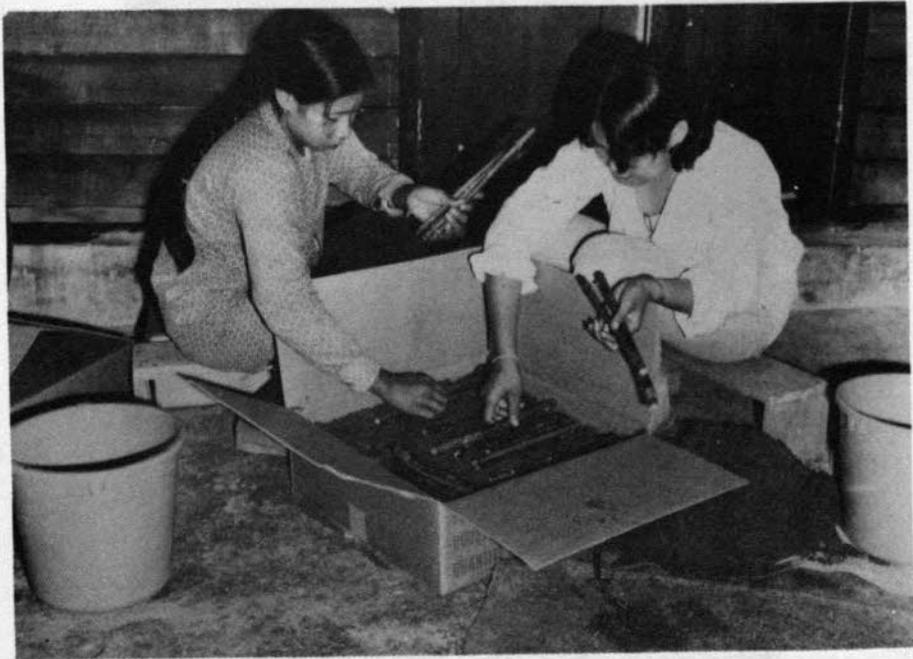


Plate 11. Budsticks being packed for despatch.



Plate 12. The emerging scion growing from the bud-patch becomes the clonal material once the root stock is budded and cutback.

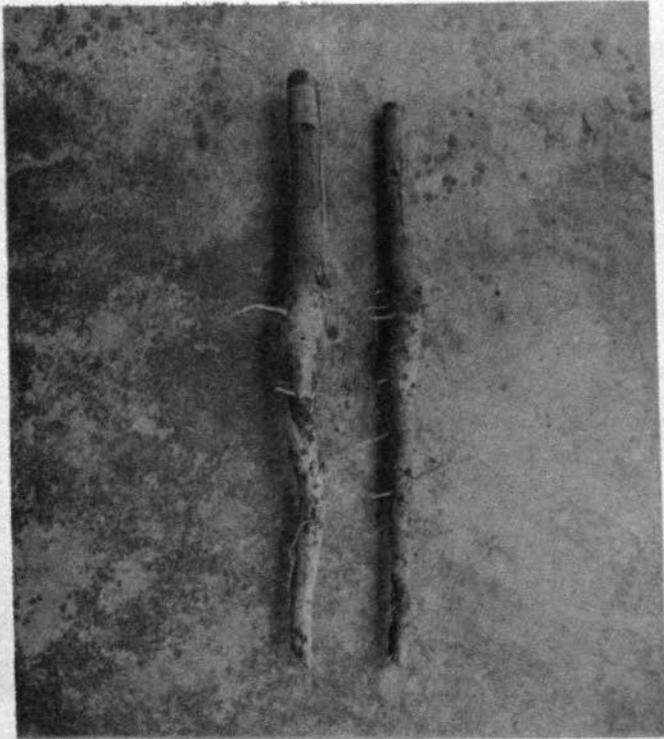


Plate 13. Comparison of a green budded stump (right) and a brown budded stump (left).



Plate 14. Budded stump being transplanted into the field with the aid of a crowbar.

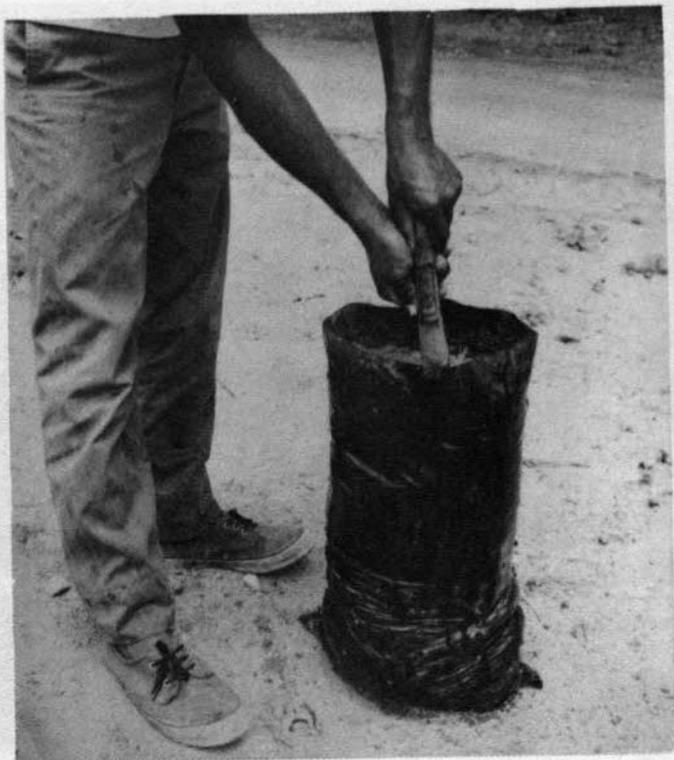


Plate 15. Budded stump being transplanted into a polybag.



Plate 16. A seedling nursery that has been cutback four weeks after budding in order to produce mini stumps.



Plate 17. A mini stump nursery with four months scion growth.

treated with a tree dressing (2295 C grease). The stem is then white washed (Plate 18) using hydrated lime (calcium hydroxide). The tap root is severed (Plate 19) at 40 cm from ground level just before extraction after which the laterals are trimmed.

The field planting procedure is similar to that adopted for stumped buddings detailed below.

Stumped buddings. About a month before preparing for field planting, all usable stumps, usually from 9 - 14 cm (3.5 - 5.5 in.) in girth, have to be roughly graded into four or five grades on the basis of vigour. During subsequent transplanting, the stumps have to be transplanted in batches according to girth sizes to ensure uniformity in field planting.

At about six weeks before transplanting, the stumps are root pruned by cutting a trench down along one side of the plant and severing or tailing the tap root at a depth of 45 - 50 cm (18 - 20 in.). The trench is then partially filled in.

Field planting should coincide with the rainy season. About ten to fourteen days before planting, when the field is already fully prepared, the stumps are pollarded (Plate 20) at a height of about 200 - 250 cm (7.5 - 8.5 ft) just below a whorl of dormant buds. The cut end is treated with wound dressing or tree dressing (2295 C grease).

The stumps are then white washed (Plate 21) immediately with hydrated lime. This practice of white washing improves the establishment success of the stumps by about 25 - 30% (Yoon⁴⁹). It is advisable to prepare the lime at least 48 h before application to prevent scorching and damage to stumps. Depending on the vigour of the plants and the weather conditions, bud emergence normally takes place between eight to ten days after pollarding.

Stump extraction (Plate 22) for transplanting should be carried out immediately after bud emergence at about 0.5 cm (0.2 in.). Transplanting at a stage when the buds are longer than this will entail a considerable amount of damage to the tender buds. On the

⁴⁹Yoon, P.K. (1972) op. cit.



Plate 18. A mini stump in a nursery being white washed with hydrated lime after being pollarded above a whorl of buds at about 60 cm height.



Plate 19. The tap root of a mini stump in a nursery being severed at about 45 cm from union just before extraction.



Plate 20. An eighteen-month-old budding in a nursery being pollarded at a height of 250 cm and just below a whorl of dormant buds for use later as a stumped budding.



Plate 21. A pollarded budding in a nursery being white washed with hydrated lime immediately after the top has been severed.

other hand, transplanting before bud emergence will result in greater failure. In removing the stumps, the laterals are to be cutback to a length of 15 cm (6 in.) and the roots inspected for root disease. Where indications of root disease exist on the tap root, the infected stumps are culled. Where infection is confined to the laterals, these are pruned off.

The stumps should then be loaded preferably onto low trailers for transport into the field. Loading should be done with due care, holding the central portions of the stems only. Each layer of stumps should be covered with sacking or lalang or other suitable materials e.g. cut grass to prevent bruising.

In the field, the planting hole should not be too deep. The ideal size is 60 x 60 x 30 cm (2 x 2 x 1 ft). In the centre of each hole, a small cavity, 15 - 25 cm (6 - 10 in.) deep is made by using a sharp wooden stick or crowbar. The end of the tap root (Plate 23) of the stumped budding should be firmly wedged (Plate 24) into the cavity to ensure that there is no air pocket between the cut-end of the tap root and the soil (Figure 7). Rock phosphate at 113 g (4 oz) per planting hole should then be mixed with the top soil; the soil is filled into the hole and pressed firmly around the base of the tree to ensure firm anchorage (Plate 25). The planting hole should then be covered by mulch of lalang or other suitable material covering a circular area of 150 cm (5 ft) diameter. It is important that field planting should be done only during the wet period, which is the normal planting season. A prolonged period of drought of more than ten days can cause considerable losses. However, if a dry spell ensues after transplanting due to wrong timing, watering is recommended. A minimal rate of 9 - 14 litres (2 - 3 gal) of water per planting hole applied at least once in four to five days will be sufficient. This is more economical than re-supplying a large number of vacancies caused by failure.

Polybag-raised plants. After budding, when the plants have reached the stage of one hardened whorl to six or seven hardened whorls (including the top whorl), they (Plates 26 and 27) are ready for transplanting in the field. The bags have to be lifted to ensure that the tap root has not grown out of the bag onto the ground. Those roots which have grown out of the polybags have to be severed

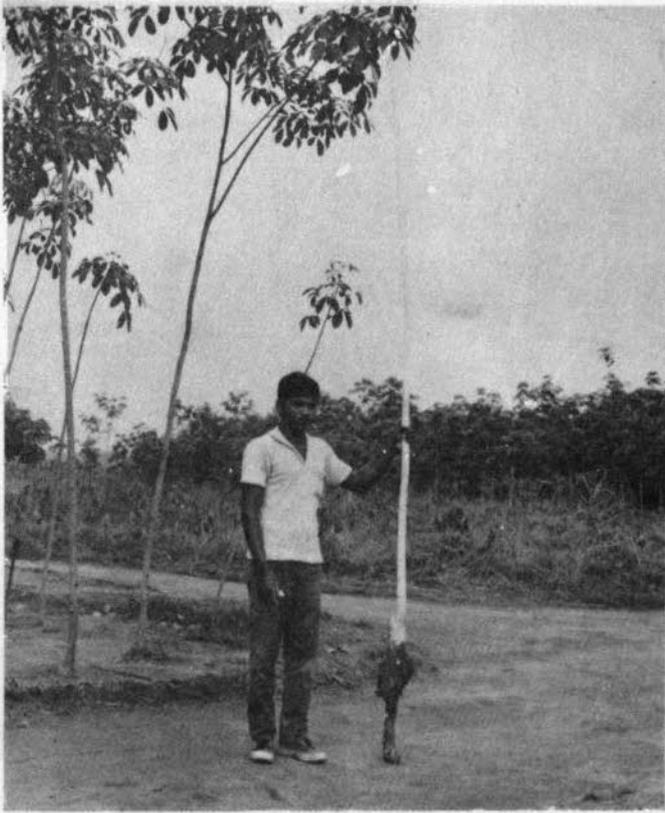


Plate 22. A stumped budding after extraction and root pruning.



Plate 23. The tap root of a stumped budding being placed into the small cavity created in the planting hole to a depth of 15 - 25 cm by means of a crowbar.



Plate 24. A crowbar being used to compact the soil around the tap root after it has been wedged into the cavity to ensure that no air pocket remains.



Plate 25. The soil is pressed and consolidated around the base of the stumped budding to ensure firm anchorage.



Plate 26. A polybag nursery.



Plate 27. Two-whorl polybag-raised buddings being loaded onto a lorry for transport to a permanent nursery site in order to raise the polybag plants to six-whorl stage. [Polybags in the foreground (on ground) are failures from the budded stumps planted in polybags three months earlier].

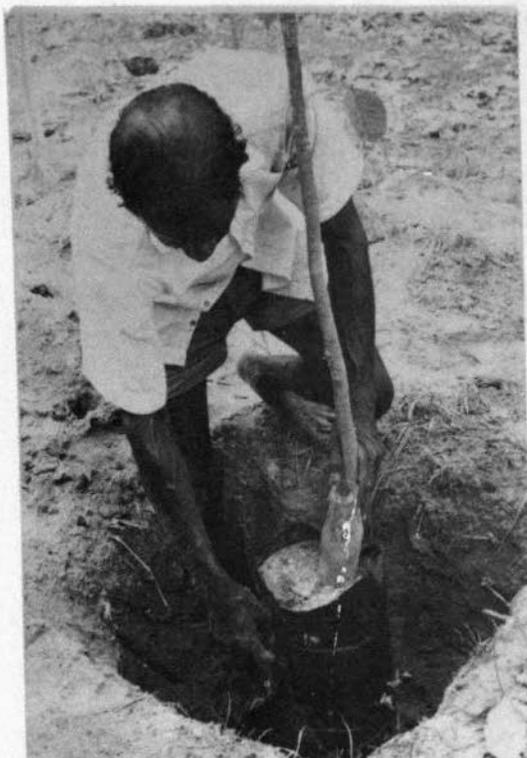


Plate 28. Polythene bag being cut after being placed in the planting hole.



Plate 29. Polythene bag being removed completely after being cut on the sides and at the base.

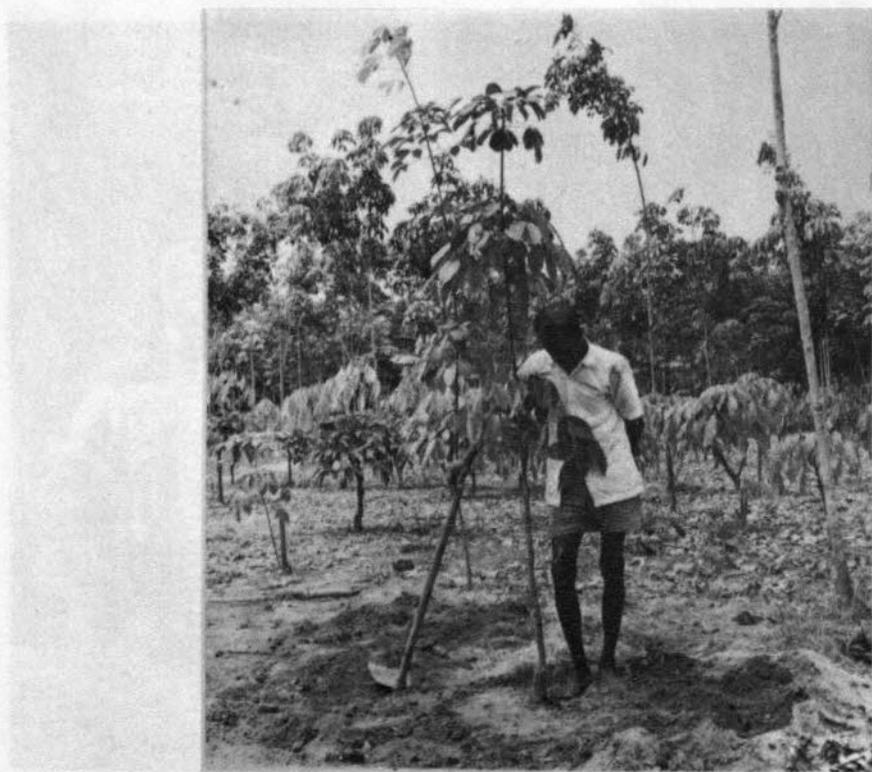


Plate 30. The planting hole is filled with the dug soil after CIRP has been incorporated and the soil pressed and consolidated to ensure firm anchorage.

and replaced on the ground or trenches (as the case may be) for five to seven days to overcome the shock. Regular watering may be needed during this period.

The bags are loaded preferably onto a low trailer for transport to the field. Since the plants would have reached about 180 - 210 cm (6 - 7 ft) during transplanting, it is necessary to place the bags securely in the trailer and support the aerial portions using wooden scaffoldings.

As each bag may be too heavy for one person, it is advisable to put the bags in specially constructed boxes during transfer from the nursery to the trailer or from the trailer to the field. Each box with a capacity for three to four bags can be fitted with handles to enable two men to carry. It is emphasised here that timing of transplanting is critical as a drought period of five to ten days immediately after transplanting will result in severe losses.

The polybag plants should be planted in 60 x 60 x 60 cm (2 x 2 x 2 ft) planting holes. The polythene bag must be first placed inside the planting hole, it is then stripped open (Plate 28) and removed (Plate 29). This will prevent the soil core from being unduly disturbed. The stripped polythene sheets can be used as mulch around the plant. About 113 g (4 oz) of CIRP must be incorporated into the planting hole. The hole is filled with the dug soil which must be firmly pressed in (Plate 30).

Working Capital

The long-run requirements for working capital are determined by the nature of the business and the volume of sales. The working capital requirements of a business are determined by the nature of the business and the volume of sales. The working capital requirements of a business are determined by the nature of the business and the volume of sales.

CHAPTER V

ECONOMIC CONSIDERATIONS

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CHAPTER V

ECONOMIC CONSIDERATIONS

Planting Density

Two long-term experiments comparing yields and other factors at different planting densities were undertaken by the R.R.I.M.^{50,51}. The major results summarised by Lim⁵² for economic analyses of both estates and smallholdings are reproduced in Tables 18 and 19. These clearly show that although yield per tree is significantly greater at lower densities, yield per hectare increases with density.

In the experiment where thinning was not done, the mean yield per hectare of AVROS 50 with an initial stand of 1075 trees per hectare was 26% higher than that secured by a stand of 309 trees per hectare (Table 18). Where thinning was practised, the mean yields per hectare of PBIG and Tjir 1 seedlings with an initial stand of 1075 trees per hectare (thinned to 430 trees per hectare for both clones) were about 30% and 20% higher than those with the initial stand of 371 trees per hectare (thinned to a final stand of 272 and 292 trees per hectare respectively) as shown in Table 19. The result of a survey on the productivity of high-yielding smallholdings with various tapping stands carried out in 1962/63⁵³ is shown in

⁵⁰Westgarth, D.R. and Buttery, B.R. (1965) The effect of density of planting on the growth, yield and economic exploitation of Hevea brasiliensis. Part I. The effect on growth and yield. J. Rubb. Res. Inst. Malaya, 19(1), 62.

⁵¹Buttery, B.R., Wycherley, P.R. and Barlow, C. (1969) Density of planting and degree of thinning: an experiment on Sepang Estate. Res. Archs Rubb. Res. Inst. Malaya Docum.62.

⁵²Lim, S.C. (1972) Land development schemes in West Malaysia: A study of benefits and costs. Thesis submitted for the award of Doctor of Philosophy, Australian National University, Canberra.

⁵³Lim, S.C. (1972) Ibid.

TABLE 18

MEAN YIELDS PER TREE AND PER HECTARE OF AVROS 50 PLANTED AT DIFFERENT DENSITIES (WITHOUT THINNING) OBSERVED IN A CONTROLLED EXPERIMENT AT THE R.R.I.M. EXPERIMENT STATION OVER A PERIOD OF TWENTY-TWO AND A HALF YEARS (July 1936 - January 1959)

Treatment ^a	Planting distance ^b (m)	Initial stand (tree/ha)	Mean yield ^c (kg/tree/year)	Mean yield (kg/ha/year)
A	9.1 x 9.1	119	7.91	866
B	6.1 x 6.1	267	4.36	980
C	6.1 triangular	309	3.87	990
D	4.3 x 4.3	547	2.79	1 137
E	3.7 x 3.7	746	2.31	1 112
F	3.0 x 3.0	1 075	2.01	1 251

^aBudded stumps for these treatments were planted out in November 1930 on a 16.2 hectare field.

^bOriginally in 'feet'.

^cCover a 22½-year period.

TABLE 19
 MEAN YIELDS PER TREE AND PER HECTARE AT DIFFERENT PLANTING DENSITIES (WITH THINNING) OBSERVED IN A
 CONTROLLED EXPERIMENT AT SEPANG ESTATE OVER A PERIOD OF ELEVEN YEARS (January 1948 - June 1959)

Treatment ^a	Initial stand (tree/ha)	Final stand ^b (tree/ha)	Mean yield ^c (kg/tree)	Mean yield ^c (kg/ha/year)
Replication 1 (PBIG seedlings)				
A	371	272	3.56	778
B	689	294	3.49	871
B ^a	689	381	2.92	952
C ^c	1 075	383	2.94	1 002
C ^a	1 075	430	2.77	1 009
D ^b	371	242	3.29	660
Replication 2 (Tjir 1 seedlings)				
A	371	292	3.03	769
B	689	299	3.03	829
B ^a	689	373	2.69	902
B ^b	1 075	381	2.59	879
C ^a	1 075	430	2.45	921
D ^b	371	235	3.58	758

^aBoth replications were newplantings on loose peaty clay soil. Replication 1 was planted in September/November 1937 and Replication 2 in December 1937 to January 1938. The seedlings in Treatment D of both replications were budded with Tjir 1 during April - May 1939. The trial was opened in January 1948 and terminated in June 1959.

^bIn 1955.

^cOver eleven year period.

Table 20. It shows that the mean yield per hectare of the smallholdings with stands of above 550 trees per hectare was 14% higher than those with stands of 307 - 368 trees per hectare. Another density experiment using modern clones RRIM 600 and 701 conducted by R.R.I.M.⁵⁴ at Pajam Estate was brought into production three years ago. The results are similar to earlier findings (Table 21).

Barlow and Lim⁵⁵ demonstrated that at any given price, profitability increases with rising density until a maximum stand after which profitability diminishes. This maximum profitability stand is positively correlated with price. They also concluded that at the price level of 110 - 130 ct per hectare, the fair 'Optimum' final tapped stand would be around 310 trees per hectare for estates. The optimum stand is 310 - 430 trees per hectare for smallholdings operated by hired workers and 620 trees per hectare for smallholdings operated by family labour. For a given price, an increase in yield will result in a higher optimum stand because the marginal revenues will be greater than the marginal cost. Similarly, at a given yield level, a rise in price will give the same result. On the other hand, at a given yield and price, an increase in the cost of production, especially tapping wages, will lead to a lower optimum stand.

In view of the improvements in the productivity of modern planting materials and the likely increase in costs due to inflation, a fresh economic analysis has been undertaken using the same experimental results employed by Barlow and Lim⁵⁶. The basic assumptions include an upward adjustment of the yield level to that of RRIM 600, a maximum task size of 600 trees (for a normal estate stand of 330 trees per hectare) and adjusted tapping systems to allow for ethrel stimulation.

⁵⁴ Rubber Research Institute of Malaysia (1974) Private communication.

⁵⁵ Barlow, C. and Lim, S.C. (1967) Effect of density of planting on the growth, yield and economic exploitation of Hevea brasiliensis. Part II. The effect of profit. J. Rubb. Res. Inst. Malaya, 20(1), 44.

⁵⁶ Barlow, C. and Lim, S.C. (1967) Ibid.

TABLE 20
 AVERAGE YIELDS OF LATEX PER HECTARE ON HIGH-YIELDING SMALLHOLDINGS
 WITH VARYING TAPPING STANDS 1962/1963

Tapping stand ^a (tree/ha)	Holding		Amount of latex ^b (kg/year)
	No.	Total (%)	
Upto 245	30	6.1	800
246 - 306	49	9.9	954
307 - 368	96	19.4	1 021
369 - 430	146	29.5	1 010
431 - 492	107	21.6	1 125
493 - 554	49	9.9	1 084
Above 554	18	3.6	1 199
Total	495	100	1 035

^aLower stands were deliberately aimed at through thinning.

^bThe amount of lower grade, forming about 20 - 25% of the total crop was not available.

TABLE 21
 MEAN YIELDS PER TREE AND PER HECTARE AT DIFFERENT PLANTING
 DENSITIES OBSERVED IN A CONTROLLED EXPERIMENT AT PAJAM
 ESTATE, SELANGOR (November 1970 - December 1973)

Treatment	Initial stand (tree/ha)	Mean yield (kg/tree)	Mean yield (kg/ha/year)
<u>RRIM 600</u>			
A	211	6.18	1 180
B	297	4.26	1 048
C	399	4.42	1 356
D	557	3.08	1 409
E	741	3.33	1 715
F	1 067	2.54	1 377
<u>RRIM 701</u>			
A	211	5.66	1 145
B	297	4.72	1 317
C	399	4.04	1 477
D	577	3.13	1 504
E	741	2.48	1 498
F	1 067	1.96	1 365

The estimated present gross profits for estates at different levels of price and density are summarised in Table 22. At the price level of 120 ct per kilogram, the present gross profit rises progressively from \$10 250 for a stand of 125 trees per hectare to \$12 340 for a stand of 370 trees per hectare. The maximum gross profit is higher at 160 ct per kilogram; it increases from \$12 190 for a stand of 125 trees per hectare to \$16 560 for a stand of 430 trees per hectare. The increase in rate of profitability is relatively higher at the initial stage, about 14 - 16% compared with 2 - 4% at higher densities. It is likely that costs will increase in the future and the optimum density is expected to be somewhat lower than the level indicated in Table 22. It is therefore reckoned that a fair optimum of tapping stand for estates would be around 370 trees per hectare rather than 430 trees budgeted in this analysis. Since thinning is discouraged, the initial stand should be about 10% higher to allow for natural losses.

For smallholdings, two systems of operation have been assumed:

- o Holdings operated by share-croppers.
- o Holdings operated by family labour.

The estimated present gross profits are detailed in Table 23 which shows that the optimum stand for smallholdings depends on the system of operation. In the case of share-cropped holdings, the optimum stand works out at 432 trees per hectare. The optimum stand is higher at 620 trees per hectare on holdings operated by family labour.

For the same reason of expected higher costs in the future, a final stand of 400 trees per hectare in tapping is considered optimum for holdings operated under the crop-sharing system. Since no tapping loss is involved in family operated holdings, the desirable density is about 620 trees per hectare.

Establishment Costs of Different Types of Planting Materials

Reduction in the immature period as a means to maximise returns to investment is effected through the use of advanced planting materials such as mini stumps, buddings in polybags and

TABLE 22

TOTAL ESTIMATED PRESENT^a GROSS PROFITS PER HECTARE OF INCREASING STANDS AT THREE PRICE LEVELS
UNDER ESTATE CONDITIONS^b

RSS 1 price level	Maximum number of trees in tapping per hectare						
	125	250	310	370	430	495	
120 ct/kg	10.25	+1.47 ^c	+0.40	+0.22	-	-0.28	-0.23
140 ct/kg	11.56	+1.75	+0.51	+0.32	+0.13	-0.11	-0.24
160 ct/kg	13.19	+2.09	+0.64	+0.42	+0.22	-0.22	-0.14

^a Discounted at 10% per annum.

^b The tapping system is assumed at S/2.d/2 for the 1st to 10th year of tapping. S/2.d/2 + 10% ethrel for the 11th to 20th year and 2S/2.d/4 + 10% ethrel for 21st to 23rd year. The wage rate follows that of the 1972 MAPA/NUPW Wage Agreement.

^c Incremental value over proceeding stand.

TABLE 23
TOTAL ESTIMATED PRESENT^a GROSS PROFITS PER HECTARE OF INCREASING STANDS AT THREE PRICE LEVELS
UNDER SMALLHOLDING CONDITIONS

System ^b and price level	Maximum number of trees in tapping						
	125	250	310	370	430	495	620
<u>Share-cropping</u> 60:40	\$600	\$'000	\$'000	\$'000	\$'000	\$'000	\$'000
120 ct/kg	5.26	+0.89 ^c	+0.24	+0.13	+0.02	-0.13	-0.25
140 ct/kg	6.18	+1.06	+0.30	+0.18	+0.06	-0.10	-0.21
160 ct/kg	7.23	+1.25	+0.37	+0.24	+0.11	-0.06	-0.15
<u>Share-cropping</u> 70:30							
120 ct/kg	6.15	+1.05	+0.30	+0.14	+0.10	-0.10	-0.21
140 ct/kg	7.22	+1.24	+0.37	+0.24	+0.11	-0.07	-0.15
160 ct/kg	8.45	+1.47	+0.45	+0.30	+0.16	-0.03	-0.09
<u>Family labour</u>							
120 ct/kg	10.41	+1.80	+0.58	+0.40	+0.25	+0.03	+0.01
140 ct/kg	12.28	+2.14	+0.70	+0.50	+0.33	+0.09	+0.11
160 ct/kg	14.18	+2.48	+0.82	+0.73	+0.41	+0.15	+0.20

^aDiscounted at 10% per year.

^bIt is assumed that 40% of the latex revenue goes to the tapper in the 60:40 share-cropping system and 30% of the latex revenue and the entire scrap revenue go to the tapper in the 70:30 share-cropping system. No labour cost is imputed for family labour.

^cIncremental value over proceeding stand.

stumped buddings. Such materials, however, incur higher establishment costs relative to conventional materials. Detailed cost data in this respect have been obtained from R.R.I.M. planting material projects on smallholdings in Kuang, which include establishment of decentralised nurseries and subsequent field planting. The decentralisation of supply sources of planting materials confers several benefits as the nursery is sited in close proximity to holdings to be planted. Cost and losses arising from transport and handling are minimised while more efficient use of the land can be made through utilising the interrow area for production of planting material. Cost evaluation of these projects performed by Ti et al.⁵⁷ is discussed below.

Nursery cost. The planting materials for which relative costs are discussed include budded stumps, mini stumps, buddings in polybags and stumped buddings. Table 24 gives the breakdown of unit costs incurred in the production of the different materials. A more detailed breakdown of material and labour costs in the various operations is given by Ti et al.⁵⁸. It should be mentioned that budded stumps are the starting materials used to establish buddings in polybags while stumped buddings are prepared in a source-bush nursery. In the latter, buddings established from budded stumps are allowed to grow without being pollarded. Its cost of production should therefore be viewed in the light of this method of production. Table 24 illustrates a variation in unit production costs after taking into consideration the cost of capital as returns to investment will not be forthcoming until six to twelve months after initial establishment. A direct relationship between interest and level of production costs is evident but in the case of stumped buddings the relatively higher interest registered is attributed to the longer preparation period in the nursery.

Field planting. The average cost of field preparation on holdings to be replanted in the project area totalled \$287.10 per

⁵⁷Ti, T.C., Subramaniam, S. and Gopalan, A. (1974) An evaluation of rubber planting material projects on smallholdings. Proc. Rubb. Res. Inst. Malaysia Plrs' Conf. Kuala Lumpur 1974 (in press).

⁵⁸Ti, T.C. et al. (1974) Ibid.

TABLE 24
UNIT PRODUCTION COSTS OF DIFFERENT PLANTING MATERIALS ON DECENTRALISED NURSERIES
LOCATED ON SMALLHOLDINGS (CENTS)

Operation	Planting material			
	Budded stump	Mini stump	Polybag ^a	Stumped budding
Preplanting ^b				
Planting	1.55)		25.52)	
Budding	1.28)	19.14)	40.70)	53.18
Watering	8.52)			
Weeding	0	0	10.74	0
Manuring	3.79	5.45	2.30	0
Tailing	1.55	9.35	10.07	0
Pollarding and white washing	0	0	0	3.43
Extraction	0	1.96	0	6.86
Others	0.50	1.41	0	5.14
Interest capital	0	0	3.19 ^c	0
	1.00	2.40	4.30	6.70
Total	18.19	39.71	96.82	75.31

^aThree-whorl buddings in polybags.

^bLand/site preparation.

^cTransfer of polybags from wooden frames and spaced in rows on the ground.

hectare. A breakdown of this cost shows that \$250 was accounted by felling, ploughing and harrowing, \$29.50 by pegging and lining and \$7.60 by the holing operation.

Table 25 gives the variation in field planting rates and costs of the different materials. This variation stems primarily from differences in transfer costs from the nursery to the field and labour input in field planting. As expected the more advanced and bulky materials such as polybags and stumped buddings incur relatively much higher unit planting costs.

TABLE 25
FIELD PLANTING RATES AND COSTS OF DIFFERENT PLANTING MATERIALS

Material	Average distance from nursery to field (km)	Cost of transfer (ct/unit)	Unit planted per manday ^a	Planting cost (ct/unit)	Total cost of planting (ct/unit)
Budded stump	1.6	0 ^b	180	1.9	1.9
Mini stump	1.6	0.6	135	2.6	3.2
Polybag	0.2	13.8	60	5.8	19.6
Stumped budding	8.0	6.7	75	4.7	11.4

^aAt \$3.50 per 8 h day

^bNegligible. Take the smallholder 15 min to transfer 180 stumps by bicycle.

Overall establishment costs. The variation in cost of preparing and field planting of different materials will significantly influence the relative total costs of establishment. Table 26 gives the unit cost of establishment in the nursery and field, taking into account nursery losses and replacement of failures in the field. The field cost per point including allowances for replacement will be influenced by planting success. In practice therefore, this cost may vary between holdings even though the costs of material are similar.

The total cost of establishing one hectare of rubber in the project area with different planting materials is shown in Table 27. Although significantly higher costs are evident in more

TABLE 26
COST OF ESTABLISHING DIFFERENT TYPES OF PLANTING MATERIALS
ON SMALLHOLDINGS

Planting material	Nursery cost per usable plant (ct)	Field cost per point (ct)
Budded stump	18.2	22.1
Mini stump	39.7	44.6
Polybag ^a	96.8	121.5
Stumped budding	75.3	92.4

^aThree-whorl buddings in polybags.

TABLE 27
BREAKDOWN OF TOTAL ESTABLISHMENT COSTS ON SMALLHOLDINGS WITH
DIFFERENT PLANTING MATERIALS (PER HECTARE)^a

Planting material	Material cost	Field preparation	Planting cost	Total
Budded stump	72.4	287.1	7.6	367.1
Mini stump	158.0	287.1	12.7	457.8
Polybag	385.3	287.1	78.0	750.4
Stumped budding	300.0	287.1	45.4	632.5

^aPlanting distance of 9.1 x 2.7 m is employed to give 398 planting points per hectare.

advanced planting materials such as buddings in polybags and stumped buddings, these may perhaps be justified in the long run in view of the anticipated reduction of the immature period to four years. In this connection, mention should be made of present value gains occurred to a six-year period. These gains which also denote the maximum additional expenditure permitted for the four- and five-year immature periods have been computed at \$1519 and \$712 per hectare respectively (Rubber Research Institute of Malaysia)⁵⁹.

⁵⁹Rubber Research Institute of Malaysia (1974) Reduction of the immaturity period in rubber for smallholders. Smallholders Modernisation Committee: Report No.2.

TABLE 28
COMPARISON OF PROJECT AND COMPUTED BREAKDOWN COSTS AT DIFFERENT
IMMATURE PERIODS

Planting material	Immature period (year)	Additional costs over six-year immature period (\$/ha)	
		Project	Maximum permitted
Budded stump	6	-	-
Mini stump	5	90.7	712
Polybag	4	383.3	1 519
Stumped budding	4	165.4	1 519

Table 28 which relates these figures to costs obtained in the project clearly shows that the latter are far below the maximum additional expenditure that can be incurred to offset the benefits.

CHAPTER VI

POLICY IMPLICATIONS AND RECOMMENDATIONS

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Policy Implications

This report has considered at length the various constraints determining clonal performance and makes clonal recommendations accordingly. The estate sector has without delay, implemented the R.R.I.M. planting recommendations. This is not the case in the smallholding sector where very little use is made of the high-yielding clones may be because of organisational and technical difficulties faced by the implementing agencies.

In order to bring the smallholder sector to the same level of efficiency as the estate sector, a meaningful modernisation policy has to be formulated. In the implementation of the policy it has to be borne in mind that an integrated and co-ordinated approach is essential.

Recommendations

The following recommendations are forwarded to the Ministry of Primary Industries for consideration and implementation to the smallholder sector:

- o At least two clones be planted where the holding is greater than four acres.
- o The planting density in smallholdings be 600 ± 25 trees per hectare (244 trees per acre) at tapping and the planting distance be 6.7 x 2.4 m (22 x 8 ft).
- o Regional nurseries be established in districts shown in Table 29 to supply the necessary planting materials.
- o For advanced planting materials such as stumped buddings and buddings in polybags, the nurseries be sited within the area of replanting.

TABLE 29
DISTRICTS WHERE NURSERIES SHOULD BE ESTABLISHED

State	Old rubber approx. acreage	District
Johore	216 944	Batu Pahat, Pontian, Muar, Kota Tinggi, Segamat
Perak	150 536	Tanjong Malim, Parit, Kuala Kangsar, Bidor ^a
Selangor	69 795	Serdang, Batang Kali, Kuang
Kedah/Perlis	67 689	Kulim, Jitra, Langkawi
Negri Sembilan	52 528	Kuala Pilah, Seremban
Pahang	38 023	Pekan, Raub, Temerloh ^a
Kelantan	18 063	Machang, Pasir Mas
Trengganu	15 531	Kemaman, Jerteh
Melaka	11 848	-
Pulau Pinang and Province Wellesley	1 112	-

^aPresent R.I.S.D.A. nurseries.

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