NURSERY TECHNIQUES FOR RUBBER PLANT PROPAGATION

RUBBER RESEARCH INSTITUTE OF MALAYSIA

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This report is based on both experimental and pilot project results secured over the last few years by the RRIM and compiled by a team consisting of:

Abdullah bin Hassan
Chong Kow Ming
Ismail bin Hussein
Khoo Swee Keng
Phang Ah Kow
Tan Ah Moy
Tan Peng Hua
Yew Foong Kheong
Leong Sook Kwai, Co-ordinator

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PREFACE

This report provides a general review of nursery practices in the RRIM and elsewhere. The aim is to emphasise the need for proper nursery practices in the production of the diversity of planting materials to cater for the rubber planting industry, especially that of the smallholding sector. Details of procedures for the establishment and maintenance of nursery as well as the preparation of the various planting materials are presented.

This report is a team effort of the many research workers involved in the project. In addition, special acknowledgement is made to the Project Committee consisting of Dr P.K. Yoon, Head of Plant Science Division; Encik E. Pushparajah, Head of Soils and Crop Management Division; Encik B.S. Rao, Head of Crop Protection and Microbiology Division; Encik Foo Kah Yoon for assistance with the editing, Encik-encik Hoh Lian Yong and Leong Hing Tong for the graphic illustrations and Puan Siti Rahmah bte Hj. Maskor and Encik Mohd. Yusup bin Abdullah for various processing assistance rendered.

Haji Ani bin Arope
Director
Rubber Research Institute of Malaysia

SYNOPSIS

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It is expected that an annual rate of 40 470 ha will be replanted by the smallholders' sector and about 16 180 ha by the estate sector in the near future. Working on 494 nursery points per field ha the total quantity of planting materials which may take the form of budded stumps, mini stumps, stumped buddings, soil core or polybag plants, works out to be approximately 27.9 million units per annum.

To produce that magnitude of planting materials including the budwood material, economically and timely for the planting seasons, it is vital that nursery establishment and operations be carefully planned, well programmed and efficiently executed.

This report presents a general review of nursery practices both in RRIM and elsewhere with the view of achieving the above. It consolidates information on current nursery techniques to produce and handle different types of planting materials by the rubber industry. Nursery work programmes are included to serve as guidelines for forward planning and organisation. Background information on plant in association with climate, soil, pest and disease is meant to complement the operational aspects of nursery practices and to ensure successful implementation of such techniques.

Economic analysis of costings involved in producing the various types of planting materials have been worked out. Under current rates, per unit cost is about 15 ct for budded stump, 35.5 ct for mini stump, 90 ct for stumped budding, 109 ct for stumped three-part-tree, 50 ct for two-whorl polybag plant, 116.5 ct for large polybag plant and 39 ct for two-whorl soil core budding.

With reference to smallholding sector, it is recommended that in addition to the present RISDA nurseries, more regional central nurseries be set up by the Government or Government agencies such as RISDA, so as to cater for the planting of rubber. In addition, smaller decentralised nursery on a rubber smallholding can confer some advantages to its neighbouring holdings. Careful choice and the propagation of the latest high yielding clones will benefit greatly the industry as a whole.

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INTRODUCTION

Propagation in Hevea

The earliest method of establishment of *Hevea* was by seeds whereby germinated seeds were planted at stake or as seedling stumps. However, with the realisation of the large variation in the performance of seedling rubber, vegetative propagation of selected clonal materials was introduced.

In Peninsular Malaysia, preliminary trials on brown budding were carried out by the Department of Agriculture in early 1919. An account of early work of brown budding has been published[1]. By 1936, the technique was widely practised by the estate sector and smallholdings. By this method, seeds of unknown parentage were collected and planted in the field or nursery and allowed to grow for one to two years before budding was carried out.

During recent years there has been a number of developments by budding on younger stocks. Green budding was derived from the early work of Hurov[2] of the Department of Agriculture in North Borneo. In 1962, Tinley[3] improved on this technique, whereby green budding could be carried out on stocks aged five to six months. This technique was used for large-scale implementation and to-day is a permanent feature in vegetative propagation of *Hevea*.

With the advent of green budding, the preparation of different types of planting materials has been made possible, including advanced planting materials which can reduce period of immaturity of rubber.

Tinley[4] showed that budded materials raised in nurseries could be transplanted in polythene bags. These could later be transplanted to the field after the plants reached the two-whorl

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[1]Milsum, J.N. (1921) The vegetative reproduction of selected stock of *Hevea*. *Agri. Bull. F.M.S. 9*, 107.

[2]Hurov, H.R. (1980) Green budstrip budding on two to eight month-old rubber seedlings. *Proc. Nat. Rubb. Conf. Kuala Lumpur 1960*, 419.

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

[4]Tinley, G.H., *op. cit.*

stage. Mainstone[5] demonstrated that budded materials could be raised in polythene bags to a later stage of four whorls or a height of 90 to 120 cm and successfully transplanted to the field.

Other greebudded materials used include budded stumps and soil-core transplanting of budded stumps or buddings at the first or second whorl stage.

Strivens[6] used a different approach, by using stumped buddings. These were plants which were grown up to eighteen 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.

Shepherd[7,8] tested various techniques of field establishment and showed the advantage in the use of stumped buddings. Sivanadyan *et al.*[9] showed that with improved agronomic practices, large polybag plants raised to six to seven whorls could also be used successfully as advanced planting materials.

Need for Nursery Practice

Nursery practice was adopted since the early years of the 1920's. The purpose of the nurseries then was for multiplication of planting materials for the estates. In post war years, nurseries for the establishment of planting materials for the smallholding sector was undertaken by the Department of Agriculture.

At a later stage in 1956, the Rubber Industry Smallholders Planting Material Scheme or RISPMS, was set up to carry out the functions for the production of rubber planting materials to smallholdings. In 1973, the Rubber Industry Smallholders Development Authority (RISDA) was formed by an Act of Parliament and it took over RISPMS and its functions, in addition to that of the Replanting Board.

At the RRIM, nursery techniques have been tested and improved over the years. Trials in respect of location of sites, use of different types of planting materials, fertiliser requirements and crop protection have been carried out.

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

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

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

[8]Shepherd, R., Teoh, C.H. and Lim, K.P. (1964). Responses in a PB 5/51 Planting Technique Trial. *Proc. Rubb. Res. Inst. Malaya Plrs' Conf., Kuala Lumpur, 1974*, 148.

[9]Sivanadyan, 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.

There is the need for improved nursery practice and modern nursery work should allow for good performance of plants in the field through the stringent selection for the best planting materials in the nursery. More uniformity of stand through multiplication of clonal materials is ensured. In cases where advanced planting materials is raised for planting, the immaturity period of rubber can be reduced.

Objectives of Report

The objectives of this report are:

- To consolidate existing information on the planning and implementation of nurseries.
- To detail the various techniques and procedures for the production and maintenance of the various types of planting materials.
- **To emphasise** the need for proper nursery practice in the production of advanced planting materials for field planting which will lead to shortening of the immature period of rubber.
- To review, for smallholding sector in particular, the existing nursery conditions, and to make recommendations to exploit the potentialities of nursery practices for the production of available planting materials for field establishment.

CHAPTER II

PLANT AND CLIMATE

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PLANT AND CLIMATE

The climate of Peninsular Malaysia has a seasonal rhythm and rainfall shows more obvious variation with season and locality than do temperature, humidity, sunshine and wind speed. The major variable receiving attention is rainfall as consideration of this will assist in the selection of favourable seasons or times of the year for handling and planting of materials.

Rainfall data and other climatic factors have been presented by various research workers[10,11,12] and meteorological organisations in Malaysia[13]. A brief account only is given here.

Temperature

Peninsular Malaysia is not subject to great extremes of temperature due to its insularity and moderate relief. The almost constant temperature of the surface waters at about 27°C in the seas around it is doubtless a stabilising influence, especially near the coast. Temperature ranges tend to increase northward and with distance from the coast. Thus, temperature is not a factor which is likely to limit crop growth to any great extent in the tropical region with adequate rainfall.

Length of Day

Since the sun passes rapidly over the horizon in the equatorial region, the photoperiodically effective day-length may probably be reasonably estimated as the period from sunrise to sunset. Photoperiodic and thermoperiodic responses are not known in *Hevea* although such effects might be more pronounced in North Peninsular Malaysia where the range of variation is greater.

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[10]Dale, W.L. (1959) The rainfall of Malaya Part I. *J. Trop. Geogr. 13*, 23.

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

[12]Wycherley, P.R. (1967) Rainfall in Malaysia. *Planting Manual Rubb. Res. Inst. Malaya No. 12.*

[13]Malayan Meteorological Service, Singapore (1957). Climatological Summaries: Part II - Rainfall.

Sunshine

From records of hours of bright sunshine, these hours and total solar radiation increase northward and near the coast. Fewer hours of bright sunshine may be expected during periods of heavy rainfall, which may affect growth of rubber.

Wind

The wind, more than any other climatic element, determines the seasonal rhythm of the climate in Malaysia. Although there is no alternation of summer and winter as in temperate regions, changes in the direction and speed of the air streams that cross the Peninsular, are responsible for the division of the year, in most areas, into four seasons.

There is, firstly, the north-east monsoon, when air-streams from the north-east sweep over the country. North-easterly winds, whose speed seldom exceeds 40 km per hour, prevail from November or early December until March. Secondly, the north-east monsoon is followed by an inter-monsoonal or transitional season of five to seven weeks duration. This coincides approximately with the month of April in the south, and May in the north. During this short period the winds are either weak and variable, or reduced to a calm. Thirdly, sometime in May, light south-westerly winds from the Indian Ocean advance across northern Peninsular Malaysia, and by June they become well established as the south-west monsoon. At the same time the southern part of the country experiences light southerly winds from the southern hemisphere. Both the south-westerlies and the southerlies persist until September or early October. Fourthly, the south-west monsoon is followed by a second transitional period which coincides with October and early November. There are thus, in general, two monsoonal and two transitional seasons in each year.

Rainfall

Over most of Peninsular Malaysia the general pattern of the wind seasons is reflected in the rainfall regime. The relationship varies, however, from place to place.

In general, five types of rainfall distribution may be distinguished in Peninsular Malaysia, four in the central and western parts of the country and one on the east (*Figure 1*).

1. *North-west.* The rainfall regime in this region includes two maxima and two minima in a year. The maxima coincide with the transitional seasons - a low maximum occurring in April-May, and a high maximum in October. The minima occur during the monsoons - a low minimum in February and a high minimum in June. The rainfall in January and February, when the north-east monsoon is well established, may be exceptionally low compared with that in other parts of Peninsular Malaysia. The low rainfall in December, January and February distinguishes the north-west from the remainder of the country, which in general, has a relatively high rainfall during these months.

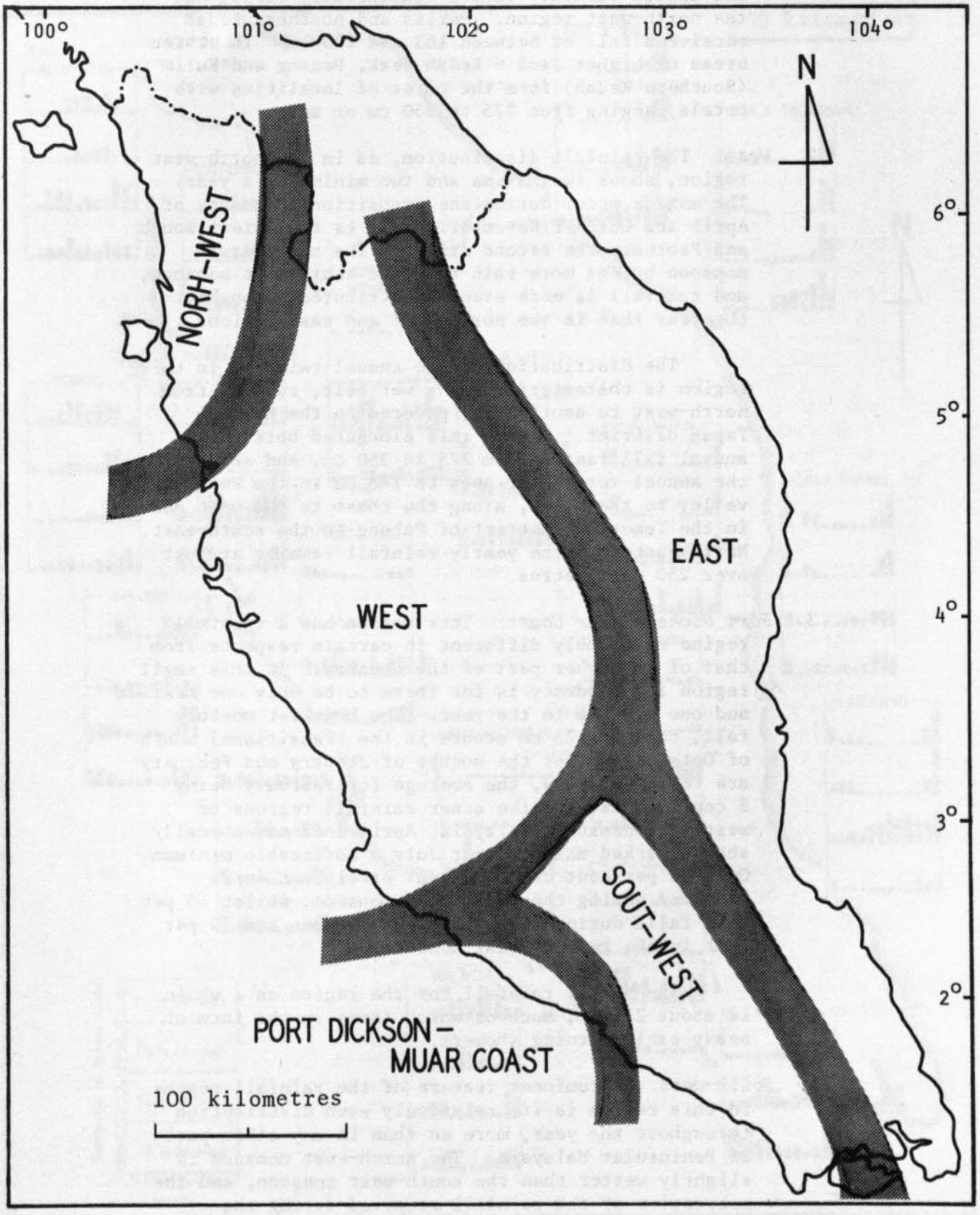

Figure 1. Rainfall regions of Peninsular Malaysia (After Dale, 1959).

The annual rainfall varies considerably throughout the north-west region. Perlis and northern Kedah receive a fall of between 163 and 225 cm. The three areas of higher land - Kedah Peak, Penang and Kulim (Southern Kedah) form the cores of localities with totals ranging from 275 to 350 cm or more.

2. *West.* The rainfall distribution, as in the north-west region, shows two maxima and two minima in a year. The maxima occur during the transitional seasons of April and October/November. July is the driest month and February the second driest. The north-east monsoon brings more rain than the south-west monsoon, and rainfall is more evenly distributed throughout the year than in the north-west and east regions.

   The distribution of the annual rainfall in this region is characterised by a wet belt, running from north-west to south-east, pivoted on the Kampar-Tapah district. Within this elongated belt the annual fall ranges from 275 to 350 cm, and around it the annual total decreases to 188 cm in the Perak valley to the north, along the coast to the west and in the Temerloh District of Pahang to the south-east. North-eastwards the yearly rainfall remains at just over 250 centimetres.

3. *Port Dickson-Muar Coast.* This region has a rainfall regime remarkably different in certain respects from that of any other part of the country. In this small region the tendency is for there to be only one maximum and one minimum in the year. The heaviest monthly fall, of about 25 cm occurs in the transitional month of October, whilst the months of January and February are relatively dry, the average for February being 8 centimetres. Unlike other rainfall regions of western Peninsular Malaysia, April does not normally show a marked maximum, nor July a noticeable minimum. Only 36 per cent of the annual precipitation is received during the north-east monsoon, whilst 45 per cent falls during the south-west monsoon and 19 per cent in the transitional months.

   The annual rainfall for the region as a whole is about 225 cm, much of which comes in the form of heavy early morning showers.

4. *South-west.* A prominent feature of the rainfall regime in this region is its relatively even distribution throughout the year, more so than in any other part of Peninsular Malaysia. The north-east monsoon is slightly wetter than the south-west monsoon, and the proportion of the rainfall received during the transitional seasons is here less than in other regions except the east. A little more than 80 per cent of the annual fall occurs during the monsoons, and less than 20 per cent during the transitional months. The intermonsoonal months of April and October/November are, at most places in this region,

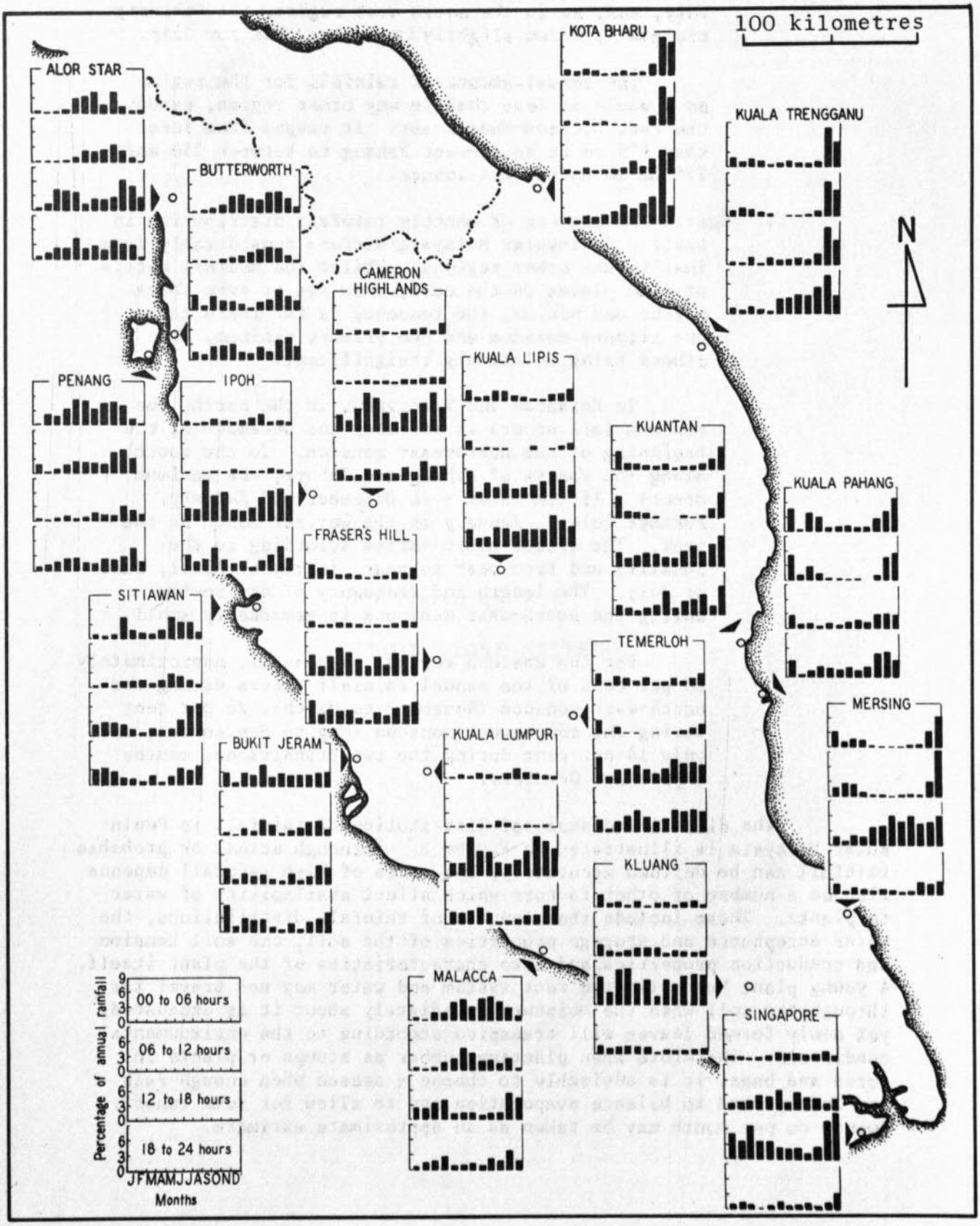

Figure 2. Diurnal and seasonal distribution of rainfall - Peninsular Malaysia (After Wycherley, 1967).

the wettest months. Minima occur in February and July, and, as in the north-west region, the February minimum is often slightly lower than that for July.

The annual amount of rainfall for the region as a whole is less than in any other region, except the Port Dickson-Muar coast. It ranges from less than 175 cm in south-west Pahang to between 250 and 275 cm in south-west Johore.

5. *East.* The pattern of monthly rainfall distribution in eastern Peninsular Malaysia differs considerably from that in the other regions. Whilst the monthly totals, at some places on the east, show two or even three maxima and minima, the tendency is for there to be one primary maximum and one primary minimum, the others being relatively insignificant.

In Kelantan and Trengganu, in the north, the maximum fall occurs in November and December at the beginning of the north-east monsoon. To the south, along the coasts of Pahang and Johore, the maximum occurs a little later - in December and January. Further inland, January is the wettest month of the year. The driest month varies according to the locality and from year to year, it may be April, June or July. The length and frequency of dry spells during the south-west monsoons is remarkably small.

For the eastern region, in general, approximately 60 per cent of the annual rainfall occurs during the north-east monsoon (November to March), 26 per cent during the south-west monsoon (May to September), and only 14 per cent during the two transitional months (April and October).

The diurnal and seasonal distribution of rainfall in Peninsular Malaysia is illustrated in *Figure 2.* Although actual or probable rainfall can be defined accurately, the value of high rainfall depends also on a number of other factors which affect availability of water to plants. These include the evenness of rainfall distributions, the water acceptance and storage properties of the soil, the soil tension and conduction properties and also characteristics of the plant itself. A young plant has a limited root system and water may not travel far through the soil when the moisture immediately about it is exhausted, yet newly formed leaves will transpire according to the environmental conditions. Therefore when planting rubber as stumps or plants in cores and bags, it is advisable to choose a season when enough rain may be expected to balance evaporation and to allow for some runoff. Twenty cm per month may be taken as an approximate estimate.

CHAPTER III

SOIL/PLANT SYSTEM

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The different soils on which rubber is cultivated in Peninsular Malaysia have different physical properties[14,15] and different chemical properties[16,17,18,19,20]. They also exist on different terrain and topography[21]. As a result of the different physical properties of the soils and the varying topography on which the soils exist, different types of soil drainage patterns[22] and different water holding capacities[23] of the soils have been reported.

Some of the soils present physical limitations to good *Hevea* performance *e.g.* hard ironstone/sandstone/quartzite band within 60 cm of the soil surface. Other soils have poor soil physical characteristics. Based on the number and severity of the soil physical

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

[15]Soong, N.K. (1973) Soil aggregation in Peninsular Malaysian soils & its influence on growth of *Pueraria phaseoloides Fert. & Chem. Trop. Soils Conf. Kuala Lumpur*, 1973.

[16]Rubber Research Institute of Malaya (1966) Soil & leaf nutrient status in relation to soil type. *Plrs' Bull. Rubb. Res. Inst. Malaya No.87*, 170.

[17]Rubber Research Institute of Malaya (1969) Magnesium: Its role in rubber cultivation. *Plrs' Bull. Rubb. Res. Inst. Malaya No.102*, 99.

[18]Rubber Research Institute of Malaya (1971) K: Its role in rubber cultivation. *Plrs' Bull. Rubb. Res. Inst. Malaya, No.114*, 129.

[19]Rubber Research Institute of Malaya (1971) N: Its role in rubber cultivation. *Plrs' Bull. Rubb. Res. Inst. Malaya No.116* 250.

[20]Rubber Research Institute of Malaya (1972). P: Its role in rubber cultivation. *Plrs' Bull. Rubb. Res. Inst. Malaya No.120*, 82.

[21]Rubber Research Institute of Malaya (1971) Terrain as a factor of soil formation. *Plrs' Bull. Rubb. Res. Inst. Malaya No.113*, 115.

[22]Rubber Research Institute of Malaya (1971) Soil drainage. *Plrs' Bull. Rubb. Res. Inst. Malaya No.114*, 146.

limitations to good *Hevea* performance, Chan and Pushparajah[24] grouped soils into five suitability classes for rubber cultivation. The varied response of *Hevea* to fertilisers on different soil situations was demonstrated[25] while the modifying effect of topography on *Hevea* growth was also reported[26,27].

Therefore, the interaction of the physical and chemical properties of the soil and topography will affect the plant nutrient/air/water availability relationship and will definitely affect *Hevea* performance accordingly.

Considerations on Soil/Site Factors

Two types of nurseries are considered: Ground Nursery and Polybag Nursery.

Ground Nursery. As the plants are grown in the ground at the nursery site, a deep, fairly heavy textured, good structured friable soil is desirable. Soils of Munchong, Prang, Segamat, Kuantan, Rengam or Jerangau are suitable.

Shallow soils of the Malacca/Gajah Mati series which have a thick laterite band close to the soil surface or Kedah series with a hard sandstone band near the surface are to be avoided in site selection for nurseries.

Very sandy, structureless soils *e.g.* Sungei Buloh series, should be avoided unless a more frequent supply of both water and fertilisers can be practised.

The poorly structured silty clay to clay soils of the Sogomana and Batu Anam series which are commonly associated with slow permeability of water in the soil and thus generally associated with a high fluctuating water table are not favourable. The poor soil structure is also unfavourable to good root proliferation and hence results in poorer plant growth.

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[24]Chan, H.Y. & Pushparajah, E. (1972) Productivity potentials of *Hevea* on West Malaysian soils. A preliminary assessment. *Proc. Rubb. Res. Inst. Malaya Plrs' Conf. Kuala Lumpur 1972*, 127.

[25]Pushparajah, E. & Guha, M.M. (1968) Fertiliser response in *Hevea brasiliensis* in relation to soil type & soil and leaf nutrient status. *Trans. 9th Int. Congr. Soil Sci. Adelaide (1968)*, 85.

[26]Chan, H.Y., Pushparajah, E. & Sivanadyan, K. (1972). A preliminary assessment of the influence of soil morphology & physiography on the performance of *Hevea*. *Proc. 2nd ASEAN Soil Conf., Djakarta 1972*, Vol. I.

[27]Chan, H.Y., Wong, C.B., Sivanadyan, K. & Pushparajah, E. (1974) Influence of soil morphology & physiography on leaf nutrient content and performance of *Hevea*. *Proc. Rubb. Res. Inst. Malaysia Plrs' Conf. Kuala Lumpur 1974*, 115.

Availability of a constant water supply is important. The source may be from a running stream, subterranean sources or from a main pipe supply. The soil medium should be such that water percolates fairly rapidly into the soil without causing the soil to be waterlogged. Sogomana and Batu Anam soils are considered as being unfavourable in this respect. Alluvial soils situated in low depressional areas near rivers or valley tracts subjected to a constant fluctuating water table is undesirable.

Soon after clearing, the nursery site has to be cultivated before planting. During the initial stages of nursery establishment, when the plants are small, the land is exposed to the weather. If the terrain is steep and the soil type is easily erodable *e.g.* Serdang series, then losses of the fertile top soil is considerable. As such, therefore, slope classification in nursery site selection is also considered. A nearly flat to gently undulating terrain will be ideal. Also, on this terrain, easy transport of planting material from the nursery to the field as well as easy supervision and maintenance in the nursery is facilitated.

Generally a fertile soil would be preferred. Judicious use of fertilisers will, however, compensate for the low fertility of most of our Malaysian soils.

As a constant supply of water is considered as one of the pre-requisites in nursery establishment, the following rating based on water availability is used (*Table 1*).

TABLE 1
RATINGS ACCORDING TO AVAILABILITY OF WATER SOURCE

		Rating (%)
1.	Readily available water source e.g. closeby to streams, pipes, ponds, etc.	100
2.	Not readily available to water source	80
3.	Difficultly available water source	40

The choice of a nursery site will consider (1) soil factor itself (2) terrain on which it occurs and (3) the availability of a water source. Therefore the soil index value will have to be multiplied by the slope factor rating (%) and the availability of water source rating (%) *e.g.* Munchong series on a 0-3% slope has a suitability rating of 85 units. If Munchong series occurs on a rolling terrain (8-16% slope) then the suitability rating decreases to $85 \times \frac{85}{100} = 73$ units. If however this site is not located at a readily available water source, then the suitability rating of the soil decreases to $73 \times \frac{80}{100} = 58.4$ units.

Polybag Nursery. As the soil will be filled into polybags, the soil medium should be of a good moisture and nutrient retention capacity. The medium should promote good root development and can bind the roots firmly enough to prevent damage during transplanting. Munchong, Prang, Segamat, Kuantan, Rengam and Jerangau series soils are all suitable soil medium.

A constant supply of water is favourable. A suitable terrain of the nearly level to gently undulating type to facilitate transport of planting material and easy maintenance of the nursery is recommended.

Soil/Site Suitability Index

Based on the above considerations of the effective soil depth to parent material/laterites/water table and the soil physical characteristics, Guha and Soong[28] proposed an index system for classifying soils as to their suitability for intercropping. This suitability index system can be adopted to rank soils as to their suitability for nursery site establishment on 0-3% slopes (*Table 2*). The most favourable or ideal condition of each factor is rated as 100%. As conditions become less favourable, the percentage value is decreased appropriately.

The slope factor rating is presented in *Table 3*. A nearly level (0-3%) slope will be ideal for site establishment of a nursery and is rated as 100%. As the slope increases, it becomes less favourable for nursery site establishment. Consequently, the suitability rating decreases appropriately to 20% for a slope of 45% and over.

Using the above indexing system, five soil suitability classes for nursery establishment can be identified.

Class I (excellent)	-	Soils with Index values between 80 - 100 units
Class II (good)	-	Soils with Index values between 60 - 79 units
Class III (fair)	-	Soils with Index values between 35 - 59 units
Class IV (poor)	-	Soils with Index values between 20 - 34 units
Class V (very poor)	-	Soils with Index values below 20 units

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[28]Guha, M.M. & Soong, N.K. (1970) Suitability & prospects of rubber growing soils for intercropping. *Crop Diversification in Malaysia* (Blencowe, E.K. & Blencowe, J.W. ed) p.15, Kuala Lumpur: Incorporated Society of Planters.

TABLE 2
SUITABILITY INDICES OF MALAYSIAN SOILS
FOR NURSERY ESTABLISHMENT*

Soil series	*Soil texture*	*Soil depth (cm) to parent material/ laterites/ water table*	*Suitability index (on flat terrain)*
Kuantan) Segamat) Prang)	Clay	130	68
Selangor)	Clay to silty clay	130 - 50	34
		50	29
Serdang)	Sandy loam	130	76
Holyrood) Tampoi) Ulu Tiram)	Loamy sand	130	57
Harimau)	Sandy clay	130	61
Klau)	Loam to sandy clay		
Jerangau)	Sandy clay	130 - 50	76
Rengam) Senai)	loam to clay loam	50	54
Munchong)	Clay sandy	130	85
Bungor)	clay loam	130	65
Malacca)	clay loam	50 - 75	55
		50	39
Sg. Buloh)	Loamy coarse sand	130	49
Batu Anam) Durian)	Silty clay	50 - 75	38
Sogomana) Sitiawan)	Silty clay	130	32

*Guha and Soong (1970)

TABLE 3
RATINGS ACCORDING TO SLOPE FACTOR*

		Rating (%)
Nearly level	(0 - 3%)	100
Gently undulating	(3 - 8%)	95
Rolling	(8 - 16%)	85
Hilly	(16 - 30%)	75
Steep	(30 - 45%)	40
Very steep	(45% and over)	20

*Guha and Soong (1970)

CHAPTER IV

DISEASES AND PESTS OF HEVEA

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Several of the diseases and pests in field plantings of *Hevea* are also found in the nursery. The causal agents of diseases are normally present throughout the year on the host plants, but only when conditions are suitable for the development of the disease, they become severe or widespread. The intensity of the above-ground diseases is closely associated with the geographical and seasonal fluctuations in rainfall, subject to different clonal susceptibilities. However, root diseases are little affected by the weather, except under extreme conditions of drought or flooding where the disease may die along with the host.

The above-ground pests are of sporadic occurrence and generally favoured by dry weather. The root-feeding insects, cockchafer grubs, have preference for sandy soils in which they can burrow readily.

The four leaf diseases, bird's eye spot, anthracnose, Colletotrichum and Oidium are found in all nurseries. Stem diseases, however are of lesser importance. Colletotrichum dieback is generally widespread and typically follows attack of Colletotrichum leaf disease. Pink disease occurs occasionally on brown stems of older buddings. Root diseases is not a problem if the site of nursery is well chosen, away from sources of infections. Polybag plantings are free from root diseases.

The above-ground pests - mites, thrips, scale insects and mealy bugs - are important in all types of nursery. Root-feeding insects such as termites and cockchafers are found in ground nurseries, but very rarely are plants in polybags affected.

Leaf Diseases

Bird's Eye Spot. The fungus *Helminthosporium heveae* is responsible for bird's eye spot. It attacks young leaves of seedling causing defoliation which weakens the plant and retards its development. Budded plants are less susceptible. The typical lesion with a transparent centre and a distinct brown margin results from attacks of young leaves which are fully expanded but still hanging limply (*Plate 1*). On very young leaves, discrete lesions are not formed but leaf margin or the whole leaf becomes blackened and shrivelled. On older leaves where the cuticle has hardened, lesions remain small appearing as brown specks. All three symptoms are often found on the same leaflet.

Bird's eye spot is often found under the crowded conditions of the nursery. The disease is severe after a short period of dry

weather on nutrient deficient soil. However, once the disease has been established in the nursery, it spreads irrespective of weather conditions because the spores are readily carried by wind, rain and dew[29].

Anthracnose. Anthracnose caused by *Colletotrichum gloeosporioides* affects young buddings. The infected leaves have spots at the edges of leaves showing characteristic target - like zones formed by lines of bristles. Spots may extend to 2 cm or more (*Plate 2*). Leaves with anthracnose are usually yellowish indicating poor growing conditions. The disease is found only in nurseries which are subject to water-logging and those with mineral deficiency.

Colletotrichum. *Colletotrichum gloeosporioides* also attacks tender expanding leaves. Under the crowded conditions of the nursery, particularly during the wet season, it can become a serious problem. It attacks young leaves from bud-burst till fifteen days later. By that time, the leaves are fully expanded, turning from bronze to pale green and have developed resistance. If the attack is at the early part of the fifteen-day period, defoliation will occur. When infection is at a later stage, the leaves do not fall off readily, but are deformed and spotted (*Plate 3*).

The development of *Colletotrichum* is much influenced by the duration of rainfall[30]. It often reaches epidemic levels during the season of secondary leaf fall on mature trees. If the rainfall is more prolonged during April/May than February/March, the disease becomes dorminant. However, it is habitually severe in South Johore.

Oidium. This disease caused by *Oidium heveae* is essentially a major disease of mature trees. In recent years there is an increase in severity on susceptible seedlings and buddings. It attacks young leaves forming a radiating net over the surface (*Plate 4*), resulting in defoliation.

Oidium can become severe and often approaches epidemic levels in the nursery during the season of secondary leaf fall on mature trees. If rainless cool weather is encountered during this period, oidium is predominant. It is much favoured by the low night temperature and high humidity that go with rainless days, although one or two rainy days are usually necessary to trigger off an epidemic[31]. Oidium is often severe in the drier districts of Malacca and Negri Sembilan.

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[29]Hilton, R.N. (1952) Bird's eye spot leaf disease of the *Hevea* rubber tree caused by *Helminthosporium heveae* petch. *J. Rubb. Res. Inst. Malaya No.14*, 42.

[30]Wastie, R.L. (1972) Secondary leaf fall of *Hevea brasiliensis:* meteorological and other factors affecting infection by *Colletotrichum gloeosporioides*. *Ann. Appl. Biol. 72*, 283.

[31]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.

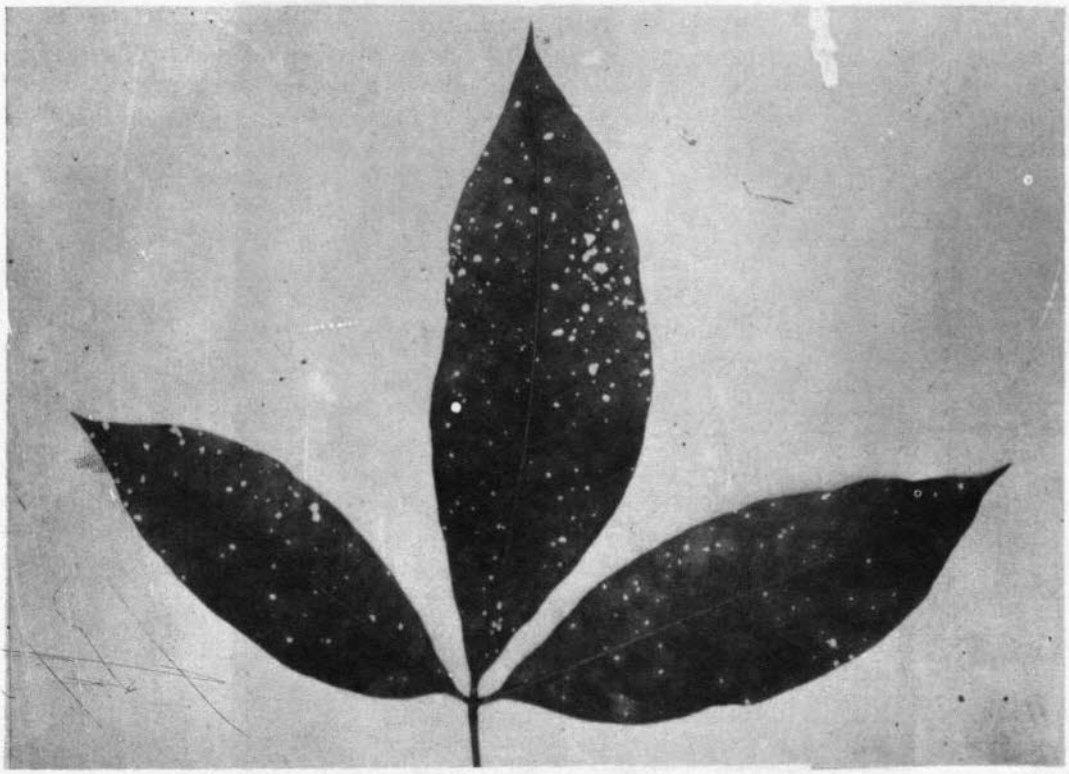

Plate 1. Mature leaf with characteristic bird's eye lesions.

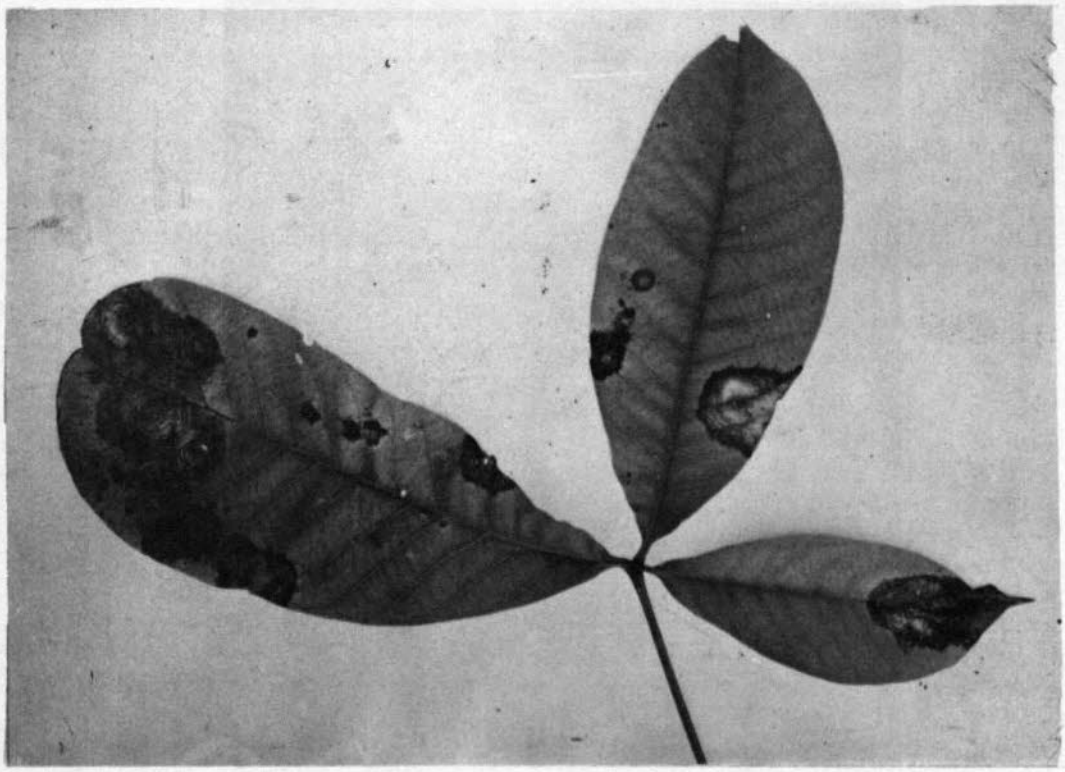

Plate 2. Leaf showing anthracnose with target-like zones formed by lines of bristles.

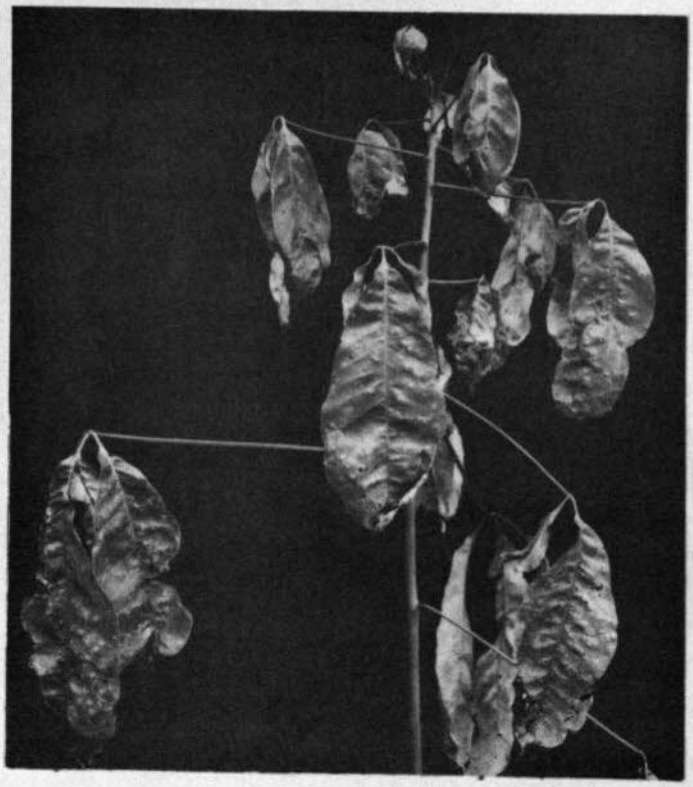

Plate 3. A young shoot attacked by Colletotrichum.

Plate 4. Mature leaf attacked by Oidium.

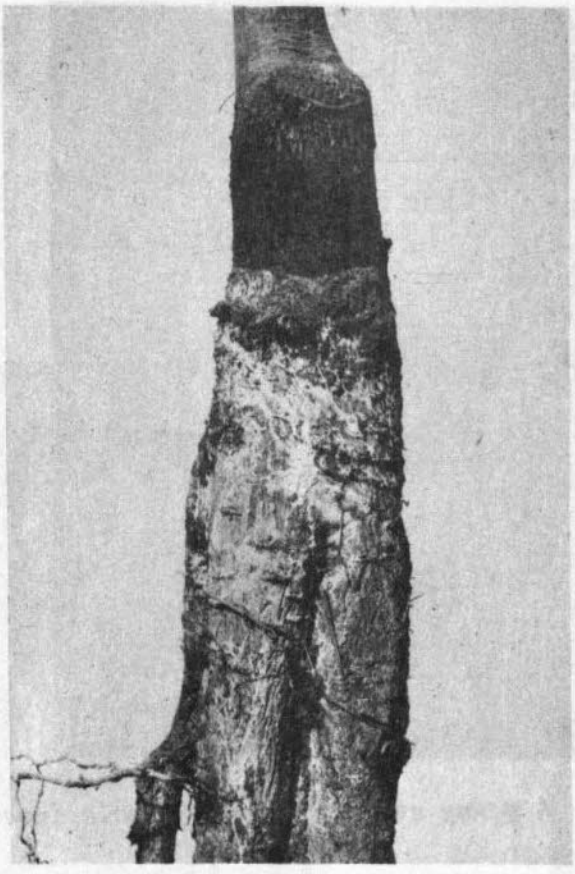

Plate 5. A stumped budding affected by white root disease.

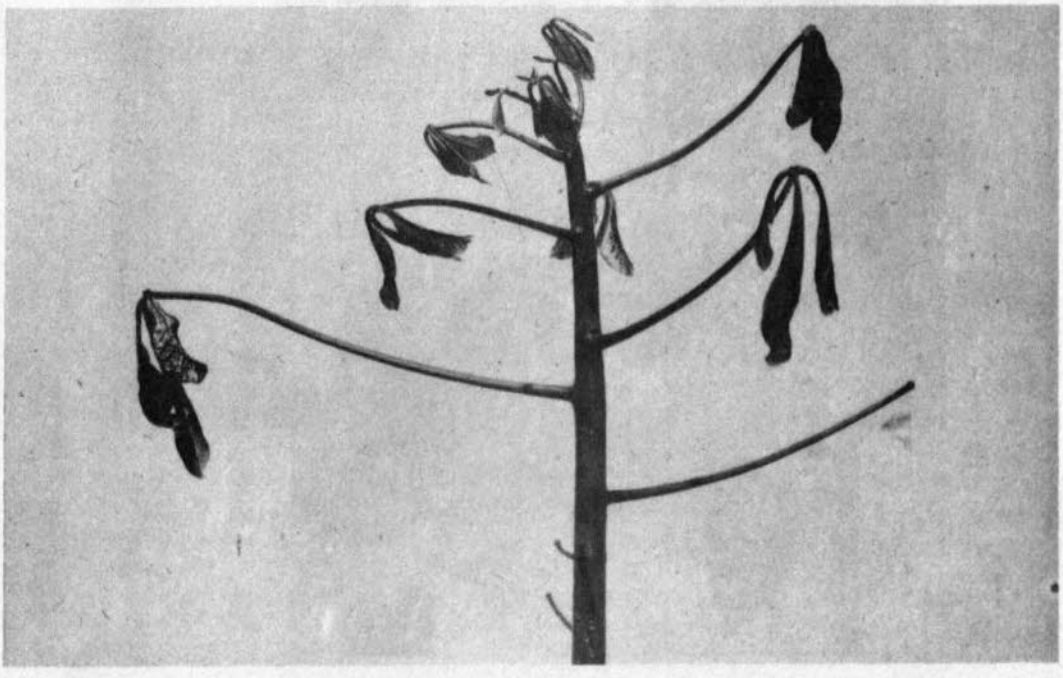

Plate 6. Top flush of a young budding heavily infested with yellow-tea mite.

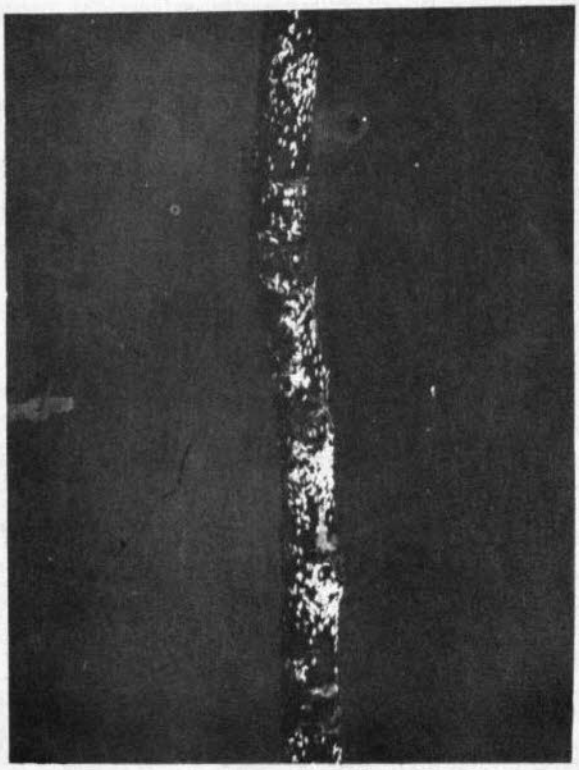

Plate 7. A young stem affected by scale insects.

Plate 8. A shoot infested by mealy bugs.

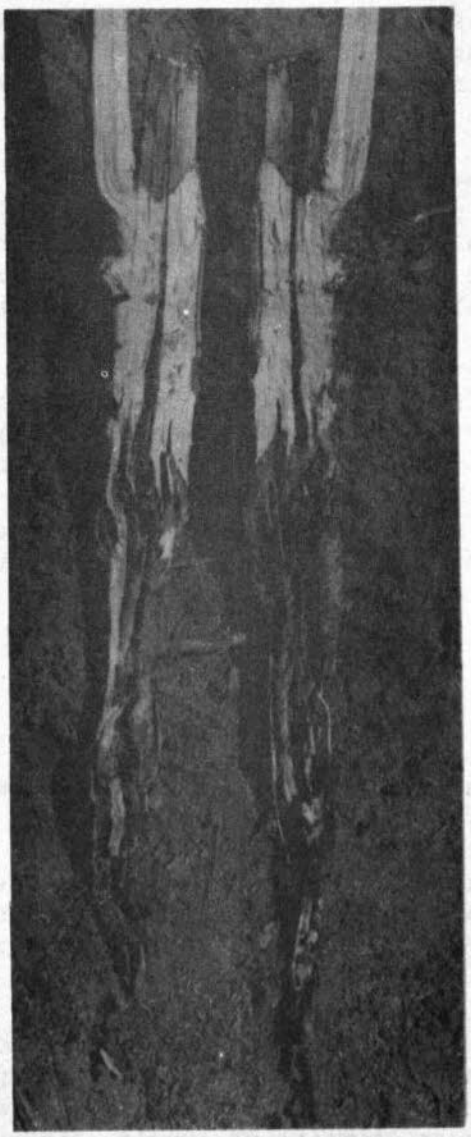

Plate 9. Root of a young budding severely damaged by termites.

Plate 10. Root of a young budding damaged by cockchafer grubs.

Stem Diseases

Dieback. Shoot dieback by *C. gloeosporioides* is particularly important in green buddings. Normally it follows severe attacks of leaf disease by the fungus. The green stems turn brown at the point of entry of the fungus and pink pustules of spore masses may be visible after a few days of wet weather. Once the stem is circled the tip dies back rapidly, followed by the whole shoot as the fungus grows downwards. In the case of green budding it may reach down to the bud patch and the whole plant may be killed.

Pink Disease. Pink disease caused by *Corticium salmonicolor* is a minor problem in the nursery. Occasionally older plants of ground nursery with brown stems may be attacked during the wet season.

The disease is prevalent during the wetter months in April/May and October/November in most parts of the country, particularly in areas with concentrated rainfall as in the northwest and northeast of the country. A survey of the occurrence of the disease has shown that it is absent in coastal area probably due to the maritime climate[32].

Root Diseases. Root diseases are rarely found in nurseries, if the site is well chosen. Sources of infection are generally stumps of jungle trees, rubber or other trees. In preparing the ground nursery on such sites, the land should be ploughed up and root collection made before the seeds are sown. When root disease appears, usually white root disease (*Rigidiporus lignosus*) (*Plate 5*), its spread among the closely cultivated plants can be quite rapid.

Pests

Above-ground Pests. The yellow-tea mite (*Hemitarsonemus latus*) and thrips (*Scirtothrips dorsalis*) are commonly present in the nursery[33]. Severe outbreaks of these can occur to cause defoliation of tender leaves (*Plate 6*). Other leaf-sucking insects such as scale insects (*Plate 7*) and mealy bugs (*Plate 8*) may build up causing defoliation and dieback. In general, these pests are of sporadic occurrence and favoured by dry weather.

Root-feeding Insects. Among the pests that feed underground are termites (*Coptotermes curvignathus*) and grubs of certain species of Melolonthid beetles known as cockchafers[33]. Termites (*Plate 9*) are fairly widespread where there are remains of jungle, old rubber or other cultivated trees. Cochchafer grubs (*Plate 10*) are a problem in certain sandy soils and adjacent to jungle where the leaf-eating adults find their host. The grubs feed on the roots resulting in loss of plants. Sometimes, severe outbreaks can occur in nurseries established in such areas.

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

[33]Rao, B.S. (1965) Pests of *Hevea* plantations in Malaya. *Rubber Research Institute of Malaya*, Kuala Lumpur.

CHAPTER V

NURSERY ESTABLISHMENT AND MANAGEMENT

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NURSERY ESTABLISHMENT AND MANAGEMENT

Basically there are two different types of nursery establishment: ground nursery and polybag nursery. The former refers to source bush, brown budwood, budded stump, soil core, mini stump and stumped budding nurseries while the latter refers to polybag nurseries which contain two to seven-whorl buddings in polybags. Nevertheless some pre-requisites which follow for establishment, are common for all the nurseries.

Clearing and Land Preparation

The extent and degree of clearing depends on the type of land for the potential nursery area. In any case, land clearing has to a large extent been done on contract basis as there are a number of experienced contractors with machinery and manpower to carry out the job in accordance with the work programmes and schedules.

Clearing areas from old rubber stand. In areas from old rubber stand, the felling contractor is normally allowed to extract all timber that has to be felled. However, all other debris such as branches, twigs, leaves and roots including uprooted stumps must be stacked and completely burnt.

Clearing areas from jungle. In cases where the potential nursery area is from jungle, the work of land clearing would inevitably cost much more as compared to clearing areas of an old rubber stand.

Prior to felling, underbrushing is normally done. This is an important operation which should not be underestimated. Good underbrushing will greatly help officers in charge of clearing to obtain a good burn and to lessen the problems associated with other work to be carried out prior to planting. The specifications for underbrushing are laid out as follows:

All blukars and small trees of 7.5 cm diameter to be cut 7.5 cm from the ground.

All hanging roots to be cut at head height and ground level or 7.5 cm from the ground.

All cut blukar should lie flat on the ground.

All bertam, bamboo and other bushes to be cut completely.

Subsequent to underbrushing, felling is undertaken. Steps should be taken to ensure that this operation, which accounts for the bulk of expenditure on land preparation, is carried out properly

since subsequent nursery work and maintenance depends on it. It should also be borne in mind that clearing of such area for nursery establishment should be carried out well in advance - that is about two and a half years before actual field planting. It is recommended that the nursery land be cleared mechanically and burning completely all wood remains to ashes. In a nursery site where the terrain is not steep, mechanical clearing using D 8 tractors may be adopted. The height at which trees may be chain-sawn is as shown in *Table 4*.

TABLE 4
SPECIFICATIONS FOR FELLING

	Dimension of trees	*Height of felling*
1.	All blukars and small trees up to a diameter of 7.5 cm to be felled first	15 cm from the ground
2.	All trees between 7.5 and 15 cm in diameter	30 cm from ground level
3.	All trees between 15 and 30 cm diameter	60 cm from ground level
4.	All trees between 30 and 75 cm diameter	90 cm from ground level
5.	All trees over 75 and 150 cm diameter	150 cm from ground level
6.	All trees over 150 cm in diameter	Should be felled at the point where the buttress roots meet the main trunk

Where trees has to be felled by chainsaw, it is always advisable to allocate two men to each chainsaw. Where a tree is struck by another and thereby breaks at a height in excess of the specifications mentioned, that tree should be cut to the required height. Trees are felled inwards from the perimeter which should have been renticed initially. All tracks and areas demarcated for nursery roads should be left clear of any fallen trees for vehicles and to ease subsequent operations.

Felled trees should be stacked mechanically and burnt after drying, that is, when their leaves are about to fall off and branches/ bark begin to split from the trunk. It normally takes between forty to sixty days for drying after felling. Firebelts of about 40 m should be provided before burning. Further, sufficient labour must be made available for burning, with at least one man per 4 ha of area with a Kepala to each group of ten labourers. At the time of burning torches, gunny sacks and kerosene should be made sufficient and burning should take place against prevailing winds. Everyone should start at the same time and the firing line must be kept in line by the Kepala carrying red flags. Various authorities such as the District Officer, Local Fire Officer, District Forest Officer should be informed of the burning. Immediately after the major burning, and

as the area is cool enough to work, pruning and stacking are carried out for reburning to ensure all wood remains are got rid of for cultivation of land. Two men operating one chainsaw with six stacking labourers could handle a 20 ha block. This work is normally done about one week after the major burning. At the same time, the firebelt is dealt with in a similar manner.

Perimeter fencing with barbed wire and wire netting should be provided to keep out wild animals. These are nailed to hardwood posts planted about 0.5 m deep and 3 m apart.

A well planned road system is necessary in the nursery area and these roads or tracks can be built at the rate of about 50 to 100 m per hectare of the nursery area.

Cultivation

In the initial establishment of ground/source bush nurseries, the land is cultivated with one ploughing and two harrowings. Mechanical cultivation of a soil at a high moisture content could destroy the soil structure and induce soil compaction. This would result in poor seedling growth and the puddled soil would also result in excessive surface runoff leading to greater soil loss by erosion.

To prevent deterioration of soil structure, mechanical cultivation should be carried out at the right moisture content. *Table 5* shows the optimum moisture content at which some of the soils could be mechanically worked.

TABLE 5
OPTIMUM MOISTURE CONTENTS FOR MECHANICAL WORKING OF PENINSULAR MALAYSIAN SOILS*

Soil series	*Optimum moisture content (% W/W)*
Kuantan, Segamat and Prang	28 - 30
Selangor, Sitiawan and Sogomana	24 - 26
Serdang, Tampoi, Holyrood, Ulu Tiram and Sungei Buloh	10 - 13
Jerangau, Rengam, Munchong, Senai & Bungor	16 - 18
Batu Anam and Durian	22 - 24
Klau and Harimau	14 - 16
Malacca	18 - 20

*Guha and Soong (1970)

If heavy machinery is used, the soil has to be worked at drier conditions (less 2% - 5% by weight, depending on soil and machinery used).

As a general rule, mechanical cultivation should not be carried out immediately after heavy rain. For sandy soils (Serdang, Holyrood) cultivation can be carried out one to two days after a heavy rain. For medium textured soils (Munchong, Rengam) cultivation should be carried out after two to three days. For the very heavy clayey to silty clay soils (Selangor, Sogomana, Batu Anam) cultivation can be carried out four to five days after a heavy rain.

Labour Management

Nursery staff will be drawn from the main management pool. But in the initial stage of nursery establishment when the main management pool is still in the planning stage, some form of semi-permanent staff will have to be recruited for the nursery operations.

Since the nursery area will be relatively big in size, one experienced senior conductor or field assistant would be able to establish and maintain the nursery efficiently. Where top management level personnel are available, their assistance should be utilised with advantage to ensure smooth operation and proper implementation of nursery work programmes.

As work on land clearing from jungle is normally done on contract, the checkroll labourers that need to be employed would only be engaged in such work as planting, budding, cutting back, maintenance, grading, pruning, etc. One Kepala or Mandore is deemed sufficient with about fifteen workers under his direct supervision.

As far as equipment and basic machinery is concerned, these should be made available for the smooth implementation of work schedules. These should include budding knives, changkuls, rakes, rottan baskets, tractors, trailers, etc.

Agro-management Practices

In order to maintain the vigour of nursery plants, whether seedling stocks or buddings, such that the plants attain buddable stage or are ready for field planting according to work schedule, optimum agro-management practices should be considered. These will include fertiliser applications, watering and the control of weeds, diseases and pests.

Fertiliser requirements. The proposed manuring schedule for green budstick/source bush nursery is presented in *Table 6*. The schedule of manuring for budded stump, mini stump and stumped budding nursery is shown in *Table 7*. *Table 8* shows the manuring schedule for polybag plants.

For ground nurseries, during the initial cultivation, magnesium limestone and CIRP are applied in the manner and at rates

TABLE 6
PROPOSED MANURING SCHEDULE FOR GREEN BUDSTICK/SOURCE BUSH NURSERY

Before Planting: 250 kg magnesium limestone/ha(plough in)
625 kg CIRP/ha(harrow in)

Months after planting	*Fertiliser type and amount (g)*	
2	56 g Mag X**	
3	56 g Mag X**	per running
4	56 g NK Mixture	90 cm
5	56 g Mag X	
	Bud at about 6 months	

Month after cutback	
1	56 g Mag X** per running 90 cm
3	28 g Mag X** per plant
5	28 g Mag X per plant
6	Prune
7	28 g Mag X per plant
9	28 g Mag X per plant
11	28 g Mag X per plant
12	Harvest budwood*
13	42 g Mixture Mag X
15	42 g Mixture Mag X
17	42 g Mixture Mag X
18	Harvest budwood*

Further application at bi-monthly intervals, dosage rates to be raised on the basis of tree performance.

(NK Mixture constitutes equal amounts of ammonium sulphate + Muriate of potash mixed)

* Harvest @ 1½ months after last application of fertilisers.
** Fertiliser containing phosphate in a soluble form is encouraged to be used.

TABLE 7
MANURING SCHEDULE FOR BUDDED STUMP, MINI STUMP, STUMPED BUDDING NURSERY

Period	*Type of fertiliser*	*Rate of application*
		Kg/ha
Before planting	Magnesium limestone (plough in)	250
	CIRP (harrow in)	625
Months after planting		*g/running 90 cm*
2	Equivalent Micture Mag X*	56
3	Equivalent Mixture Mag X*	56
4	NK Mixture	56
5	Equivalent Mixture Mag X	56
A		
	Bud at about 6 months	
Months after cutback		*g/running 90 cm*
1	Equivalent Mixture Mag X	56
		g/tree
3	Equivalent Mixture Mag X	28
5	Equivalent Mixture Mag X	28
B		
7	Equivalent Mixture Mag X	42
9	Equivalent Mixture Mag X	42
11	Equivalent Mixture Mag X	42
13	Equivalent Mixture Mag X	42
15	Equivalent Mixture Mag X	56
17	Equivalent Mixture Mag X	56
	Prepare for extraction of stumped buddings at about 18-20 months after cutback	

* Equivalent Mixture Mag X contains 9% N, 15% P_2O_5, 7% K_2O and 2% MgO where phosphate is in a soluble form. Slight variation in nutrient composition in other related fertilisers incorporating soluble P is permissible.

A - Schedule for budded stump B - Schedule for mini stump

Caution: During the initial 8 months after planting, do not use fertilisers containing nitrate nitrogen.

recommended in *Table 7* and *8*. Adequate and frequent application of fertilisers have been found to stimulate and promote rapid growth of the seedlings. A complete fertiliser as NPKMg, which incorporate a soluble phosphate, is encouraged to be used for polybag plants and during the initial fifteen months for ground nurseries.

Care has to be exercised in not scorching the plants during fertiliser application. Therefore, during application, fertilisers must not be allowed to come in contact with the stems of very young plants. Manuring must not be carried out during the stage of flushing of tender leaves. Fertilisers which incorporate nitrate nitrogen must be avoided for young plants in polybags and during the first year of planting on the ground, so as to avoid damage by scorching.

Water requirements. The rainfall pattern in the country is not uniformly distributed throughout the year. Certain periods of the year are dry and moisture stress can be experienced by the plants during this period, especially on soils with poor water retention characteristics. Sufficient moisture must be available for maximum growth. It is, therefore, essential that a ready source of water be available.

For ground nurseries, minimal irrigation during extreme dry weather can give significant results. Irrigation in small nurseries can be carried out manually with well planned and adequate pipe lines or mechanically by means of tractor-PTO-driven spray. Sprinkler irrigation method would be feasible only for large nurseries of more than 4 hectares.

For polybag plants, it is very important that the plants be watered adequately to prevent scorching of the plants due to fertilisers. Young polybag plants should preferably be watered soon after fertiliser application.

Weed control. Weeding of the nursery is essential to prevent unnecessary competition, mainly for water. During the initial stages when the plants are still tender, manual weeding is recommended. Later when sufficient brown bark has developed on the stem, appropriate herbicides such as paraquat/PP 910 can be used. The use of protection shield during spraying is being practised in some nurseries using chemical weed control. The box-like shield is moved along the interrows by two workers so that the sprays are confined to the interrows and will not affect the surrounding plants.

TABLE 8
MANURING SCHEDULE FOR POLYBAG PLANTS

Time after polybag (months)	*Dosage rate of compound fertiliser* g per bag*
At planting	56 g of CIRP
1	7
2	14
3	14
4	22
5	22
A Budding	
Time after outback (months)	
1	14
2	22
3	28
4	28
5	28
6	28
7	42
8	42
9	42

A - Schedule for small polybags ends here

* Fertiliser incorporating a soluble phosphate is encouraged to be used.

Caution: During the initial 8 months after planting, do not use fertiliser containing nitrate nitrogen.

Crop Protection

Control of Disease. Recommendations for the chemical control of diseases of *Hevea* has been summarised[35]. To protect young expanding leaves from infection by bird's eye spot, weekly spraying with 0.2% of either zineb or maneb is recommended. Continuous spraying is not necessary as the period of leaf susceptibility is two weeks after bud-burst. Normally 4-6 rounds of spraying are sufficient when new flushes are formed.

Anthracnose can be brought under control by improving the drainage of soil and by the addition of supplementary doses of fertiliser.

[35]Rubber Research Institute of Malaysia (1975) Recommendations for chemical treatment of diseases of *Hevea*. *Plrs' Bull. Rubb. Res. Inst. Malaysia 128*, 45.

In controlling Colletotrichum leaf disease, curative treatment by applying fungicides after the leaf has become infected are ineffective, but prophylactic sprays of a fungicide as young leaves emerge will inhibit spore germination. To cover the period of leaf expansion, 4-6 rounds of 0.2% Daconil applied at weekly intervals during the wet season will ensure disease-free leaves.

Oidium can be effectively controlled by the application of 4-6 weekly rounds of sulphur dusting.

Dieback can be prevented by weekly spraying of 0.2% Daconil. Older buddings in ground nursery could be saved by pruning off the dead portion of the shoot, if it has not died back to the bud-patch.

Pink disease can be controlled by brushing the affected stem with 2% Calixin formulated in natural rubber latex.

The control of root disease involves early detection of dead or dying plants and inspection of neighbours is essential to prevent heavy losses. Diseased plants should be removed, followed by tracing of infection source which should either be eradicated or isolated with trenches to prevent further spread.

Control of Pests. Good control of yellow-tea mite and thrips is obtained by spraying Dieldrex 15, diluted at 3 ml in 1 litre water and Thiodan 35, diluted at 1.5 ml in1 litre water. A repeated application after 5 days should effectively eliminate these pests from the plants[36].

Scale insects and mealy bugs can be controlled by spraying 2.5% kerosene-soap emulsion (.57 litre kerosene, .45 kg soap, 22.7 litres water). Two applications at weekly intervals may be necessary to eradicate the pests.

An occasional attack of termites 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 litre water. For controlling cockchafer grubs, the same insecticide as used for termites, but at double the concentration, should be injected into the soil around each plant in the affected patches.

Recommendations for chemical treatment of diseases and pests of *Hevea* are presented in *Tables 9* and *10* respectively.

Use of Pesticides and Residue Problems

Toxicity. The term "pesticide" is now broadly used to include all substances used for the control of "pests" (insects, rodents, etc.) as well as bactericides, fungicides and herbicides. Pesticides vary greatly in their toxicity to man. This is measured by the acute oral toxicity (LD 50 or 50% lethal dosage). This is the amount of poison which can kill 50% of the test animal (usually rat)

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[36]Rubber Research Institute of Malaya (1968) Recommendations for chemical control of pests of rubber of rubber plantations. *Plrs' Bull. Rubb. Res. Inst. Malaya No.95*, 67.

TABLE 9
RECOMMENDATIONS FOR CHEMICAL TREATMENT OF DISEASES OF HEVEA IN NURSERIES

Disease	*Cause*	*Fungicide*	*Concentration (%)*	*Method of application*	*Remarks*
Colletotrichum leaf disease	*Colletotrichum gloesporioides*	Daconil	0.2	Mistblower (knapsack portable or tractor-mounted)	Apply at least 4 rounds at weekly intervals as leaves are unfolding
Oidium leaf disease	*Oidium heveae*	Sulphur dust	9 kg/ha	Power duster (portable or tractor-mounted)	Apply at least 4 rounds at weekly intervals as leaves are unfolding
Bird's eye spot	*Helminthosporium heveae*	Zineb, maneb	0.2	Knapsack sprayer	Spray expanding leaves at weekly intervals
Pink disease	*Corticium salmonicolor*	2% Calixin in latex concentrate	Neat	Brush infected portion	Treated trees are not re-attacked for at least 3 months
Dieback	*Various fungi*	Daconil	0.2	Mistblower (knapsack, portable or tractor-mounted)	Apply at least 4 rounds at weekly intervals as leaves are unfolding
		Wound dressing (bituminous) Tar	Neat	Brush over cut surface after pruning	Cover with white-wash if exposed to 8 cm

TABLE 10
RECOMMENDATIONS FOR CHEMICAL CONTROL OF PESTS OF HEVEA IN NURSERIES

Pest	*Insecticide*	*Mammalian toxicity[a], mg/kg*	*% Active ingredient*	*Form available*	*Required dilution gm/litre*	*Rate of application*	*Method of application*	*Remarks*
Termites				Emulsifiable concentrates:				
	Dieldrin (CH)	100	0.0375	Dieldrex 15	5 in 2	570 litre or more/tree depending upon size of tree	Pour around bole after making a runnel around it	Treated tree are not reattacked for two years Prophylactic treatment feasible. In peat areas use only aldrin or heptachlor, but at 4 times the concentration
	Aldrin (CH)	50	0.05	Aldrex 2	5 in 2			
	Heptachlor (CH)	130	0.05	Heptachlor 2E	5 in 2			
	Chlordane (CH)	500	0.1	Chlordane 40%	5 in 2			
Cockchafer Grubs				Emulsifiable concentrates:				
	Heptachlor (CH)	130	0.1	Heptachlor 2E	5 in 1	1 - 2 litre/ tree, depending upon size	Pour around bole into holes made with a crowbar, within a circle of 30 - 45 cm radius	Treatment effective
	Aldrin (CH)	50	0.1	Aldrex 2	5 in 1			
Yellow tea mite and thrips				Emulsifiable concentrates:				
	Dieldrin (CH)	100	0.05	Dieldrex 15	3 in 1	56 litre/ ha	By high vol. spraying with pressurised knapsack sprayers	Spray only top flushes, but cover both surfaces. Repeat once after 5 days
	Endosulfan (CH)	110	0.05	Dieldrex Extra	5 in 2			
	Endosulfan (CH)	110	0.05	Thiodan 35	4 in 3			
Scale insects and mealy bugs				Emulsifiable concentrates:				
	Oil emulsion	Negligible	2.5	Albolineum	25 in 1	110 - 220 litre/ha	By high vol. spraying with pressurised knapsack sprayers	Spray thoroughly to cover all parts of the plant. Repeat once or twice at weekly intervals
				Kerosene-soap emulsion	25 in 1			

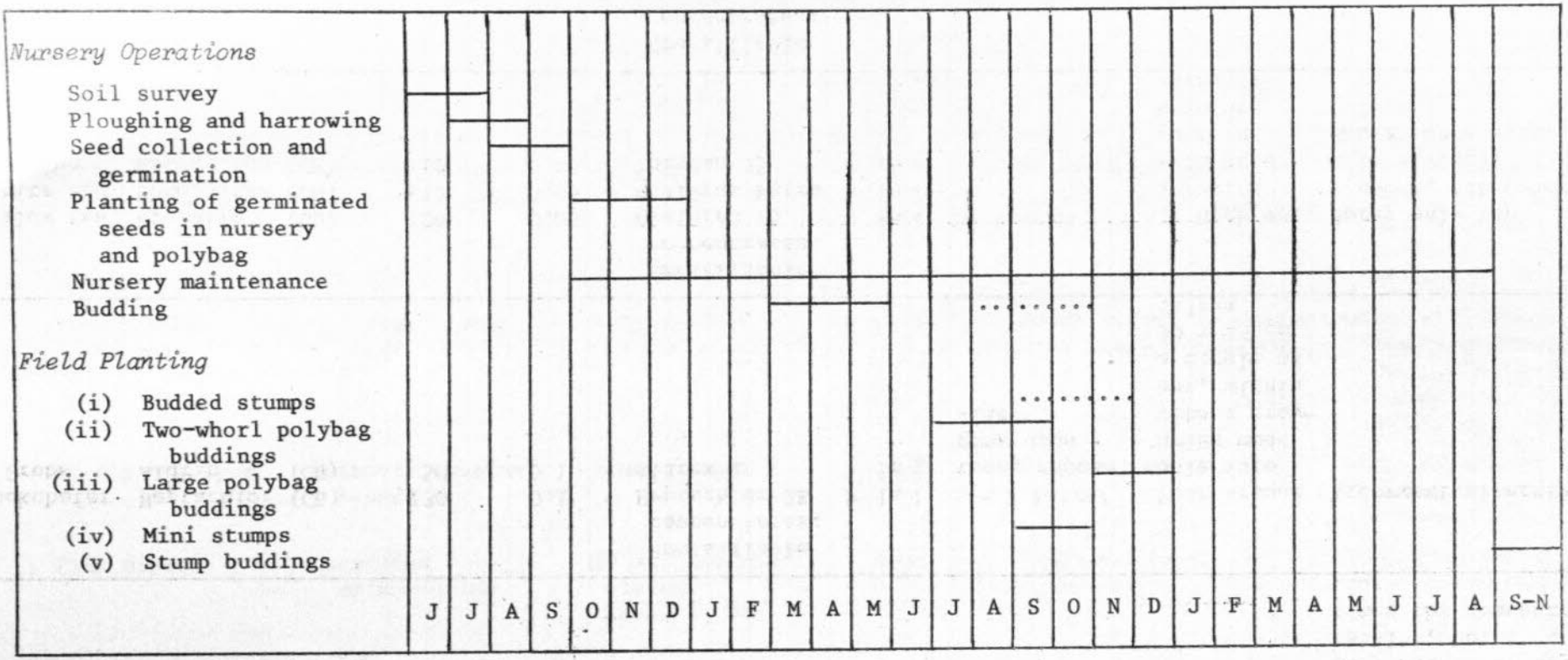

Figure 3. Proposed Schedule of Operations.

expressed in mg per milligram body weight. High LD 50 means a low toxicity. For practical purpose, LD 50 in the region of or below 100 indicates a highly toxic substance.

The fungicides used in the nursery all have low mammalian toxicity. Zineb, Maneb and Daconil are protectant fungicides and all have LD 50 greater than 5 000 mg per kilogram. Sulphur dust is practically harmless and no LD 50 is quoted. Calixin for pink disease on stem has an LD 50 or 1 000 mg per kilogram, which is quite safe and applied by brushing.

The insecticides on the whole are highly toxic. Those recommended for nursery use are Dieldrex, Thiodan, Aldrex 2 and Heptachlor 2E and all have LD 50 values in the region of 100 mg/kg or below. Only the kerosene soap emulsion is relatively less harmful.

Precautions. Care should be taken in handling pesticides, especially those that are toxic. Certain pesticides are easily absorbed through the skin and continuous exposure may lead to death. Rubber or PVC gloves should be worn when diluting concentrates with water for application to the crop. Protective clothing and goggles should be worn during dusting and spraying operations. Spraying machines should be checked for any leaks before use. Blocked spray nozzles should not be cleared by blowing with the mouth, but with a piece of wire. The pesticide residues from containers or applicators should not be emptied near streams. All empty containers should not only be rinsed out but made unusable and buried in the ground to prevent their use by those unaware of the hazard.

Work schedule. A work schedule of operations is presented in *Figure 3*. These are however only basic guidelines and as such minor modifications may be made as and when necessary.

CHAPTER VI

PRODUCTION AND HANDLING OF PLANTING MATERIALS

CHAPTER VI

PRODUCTION AND HANDLING OF PLANTING MATERIALS

The preparation and handling of different types of planting materials are considered here. Propagation of high yielding materials is made possible by the technique of green budding. To produce the clonal material, seeds have to be obtained to generate the stocks and sourcebush nurseries have to be available to produce budwood for the scion material. Thus the various aspects of seed collection, seed germination and production of source-bush nurseries are also discussed.

Seed Collection, Germination and Budgrafting

Seed collection. Before commencing with seed collection, the potential area has to be clean weeded and cleared of old seeds to prevent contamination. Seeds are collected once in two days in areas with clones Tjir 1, PB 5/51, RRIM 600, 605, 623 and 501. Areas where clonal seeds can be collected is shown in *Table 11*. The percentage germination of seeds from the main seedfall (late August to late September) is about 90% while that from the secondary seedfall (early February to late March) is about 60%. Generally, the amount of seeds to be collected and germinated must be one and a half times or double the number of plants required for field planting.

Seed viability and storage. Rubber seeds remain viable only for a short period, hence they should be used without much delay. If germination is not undertaken immediately the seeds should be stored in perforated polythene bags with damp saw dust (10% moisture) or powdered charcoal (20% water by weight). The bags are spread out and kept in a cool place. In this way, the seeds may remain viable for about three months. They may also be stored in sealed polythene bags at 4°C to remain viable for more than 4 months. Viability is prolonged by restriction of the rate of respiration.

Germination of seeds. The rubber seeds are germinated in seed-beds. There are two methods in seed-bed construction, though the height and width remains unchanged at 25 cm and 90 cm respectively and the length depends on the amount of seeds to be germinated.

a. The older method is to raise the soil to 15 cm and the soil on the seed-bed is loosened with cangkul to enable the easy penetration of root radicles on germination.

b. The second method is by the use of 25 cm planks to form troughs or boxes which are filled with aged sawdust, coarse sand or loose soil.

In both cases, a shade is essential to prevent the rapid drying of the medium and is constructed over the seed bed with jungle

TABLE 11
TOTAL AREA (HA) OF EXISTING RUBBER ON WEST MALAYSIAN ESTATES
(UP TO MATURITY - 1967) AS AT DECEMBER, 1973
STATEWISE

	RRIM 501	*RRIM 605*	*PB 5/51*	*RRIM 623*	*Tjir 1*	*RRIM 600*
Trengganu	150	153	17	288	282	248
Selangor	3 744	2 761	3 403	3 304	3 549	3 339
Johore	4 901	7 723	4 511	12 089	9 294	9 922
Kedah	1 457	3 696	2 938	4 465	4 719	4 882
Kelantan	1 081	539	221	762	529	1 491
Malacca	2 057	1 193	846	1 140	2 555	1 961
Negri Sembilan	2 220	2 959	3 965	3 626	4 685	6 285
Pahang	6 751	1 886	1 471	1 793	1 729	2 005
Penang	234	209	371	691	403	525
Perak	2 642	2 779	3 466	4 088	4 237	3 517
Perlis	15	3	-	13	48	96
Total	47 380	23 900	21 208	32 260	32 031	34 270

poles or wood of 5 cm diameter to a height of 75-90 cm. On top of this is placed the attap leaves, thick layer of lallang or hesian cloth to provide shade. *Plate 11a* shows the seed-beds with the shade.

If fresh seeds are to be germinated, they are collected, packed in gunny sacks or cartons and quickly despatched for germination on the seed-beds. Seeds should not be kept too long in the sacks or cartons since heat generated will lower their viability. They should be spread out in a cool shady place and sprinkled with water if they are not ready for germination immediately.

It is important to note that seed-beds are to be sited.

- adjacent to or within the nursery but the fertility of the soil is of little importance.
- near to water supply but not subject to flood or water-logging.

Fencing with barbed wire and 2 cm mesh wire netting is required to prevent animal damage.

Seeds should be spread and placed close to each other on the seed-bed to a single layer with the rounded or dorsal side up. Some loose soil, coarse sand or aged sawdust are spread over to cover half of the seeds to keep them moist most of the time (*Plate 11b*). The seeds are watered twice daily in the morning and evening. An area of 90 cm x 90 cm of seed-bed can accomodate about 1 000 seeds.

The sign of first germination will be about seven days after sowing the seeds. As soon as the radicles have reached 2-3 cm they are hand picked, put into baskets and then taken to the nurseries for planting. This is carried out until about the twenty-first day. Any seeds which do not germinate by then should be discarded for they will not grow into vigorous plants. Attention should also be paid to correct planting of the germinated seeds. The seed should be planted horizontally with the curved surface uppermost and the radicle pointing downwards. This is to facilitate good stem development and encourage the root to grow downwards into the soil.

Budgrafting. The different planting materials are propagated by budgrafting the scion of a selected clone onto the seedling stocks. The method of green budding which was first reported by Hurov, could be done on seedling stocks which are five to six months old. The green budsticks are obtained by cutting back a growing budding in the source bush nursery thus forcing many shoots to emerge. The green buds which are found on these new shoots are used.

The budding panel is exposed by pulling up the strip of bark and cutting away the flap leaving about 1 cm of it (*Plate 12a*). The bud-patch from which the sliver of wood has been peeled away is inserted under the flap (*Plate 12b*) and wound downwards with clear polythene tape which is tied at the end (*Plate 12c*). The stock is cutback about three weeks after budding, during favourable weather (*Plate 12d*).

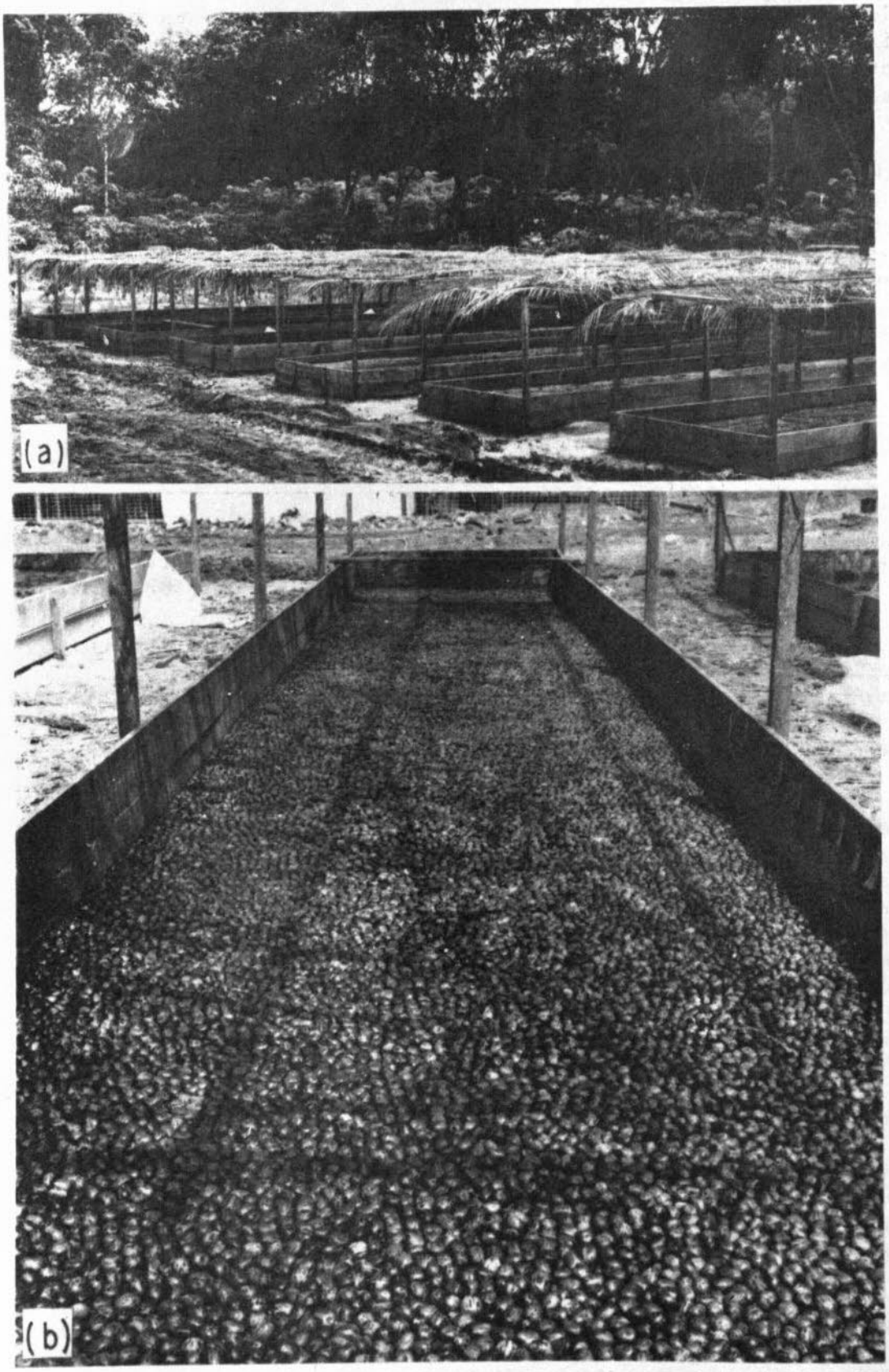

Plate 11. Germination of seeds

(a) Shaded germination seed beds
(b) Arrangement of seeds

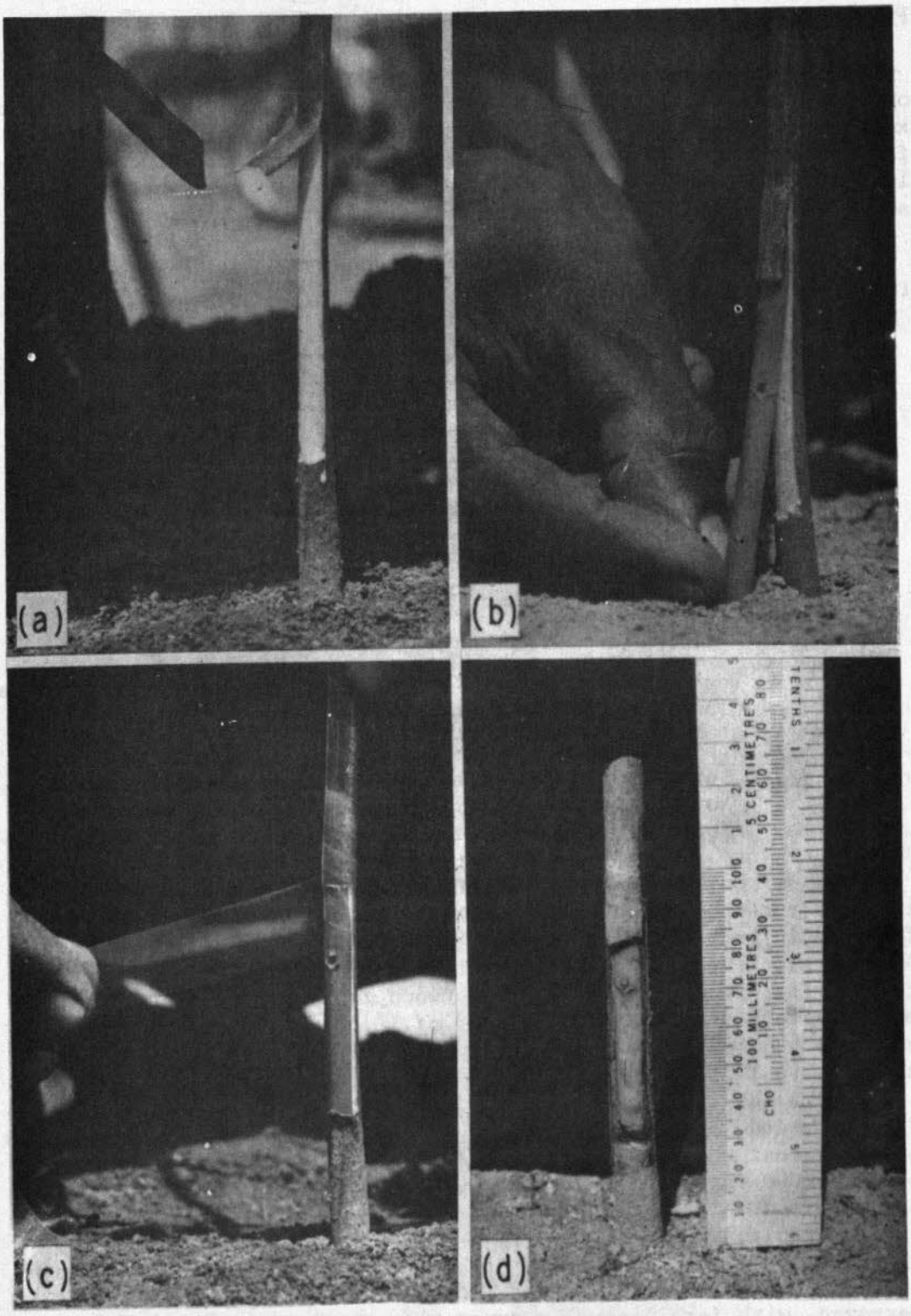

Plate 12. Technique of Green Budding

(a) Budding panel is exposed
(b) Insertion of budpatch
(c) Binding with polythene tape
(d) Cutback 3 weeks after budding.

Preparation of Planting Materials

Green budsticks. The production of green budsticks can be obtained from the source bush nursery on a planting distance of 1.2 m x 1.2 m to raise 6 721 plants per hectare but due to runts and other factors about 6 178 plants will be raised. These will produce 19 700 - 24 700 budsticks per hectare for its first harvest and an annual production of 98 840 budsticks in four rounds (*Plate 13*).

A bush nursery can be established in one of the following three ways:

- Germinated seeds are first established for green budding at 5 - 6 months old. The successfully budded plants are cut back and scion shoots allowed to grow into buddings. At about 8 - 9 months after cutback the plants are pollarded to a height of about 90 cm. Four side branches are left to grow for eight to ten weeks before they are harvested as green budwood at a few centimetres from the base. New shoots, four each, are allowed to grow from each of the four branches where shoots have been harvested earlier. This process is allowed to repeat until four rounds of green budwood have been harvested.
- Bush nursery can also be raised with green budded stumps and the rest is as described in the first method.
- A budded stump nursery can also be converted to a bush nursery by the extraction or thinning of the budded stumps to a final stand of about 6 178 plants on a planting distance of 1.2 m x 1.2 m.

Brown budwood. On a planting distance of 90 cm x 60 cm, 17 940 plants per hectare are expected but due to poor growth and failures in budgrafting, about 14 826 budded plants will be raised. On successful budding the plants are cut back and scion shoots left to grow into two yards* of brown budwood in twelve to eighteen months after cutback. From a stand of 14 826 plants, 10 000 yards of brown budwood are expected. At its first harvest, the budwood are cut about 15 cm from the union leaving sufficient buds to grow two shoots for the second harvest in twelve to eighteen months' time. For the second harvest about 15 000 yards can be expected. After the cutback, four shoots are allowed to grow for the third harvest and about 25 000 yards would be expected and so for the fourth and fifth harvest (*Plate 14*). After five rounds of budwood production, it is due for replanting.

Budded stumps. After the land has been ploughed and harrowed, with fertilisers incorporated, the land is lined with a planting distance of 60 cm x 15 cm. Planting of germinated seeds is carried out with the help of marked ropes or wires with the seventh

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*The yard is a standard unit for brown budwood and does not refer to the Imperial unit in this case. Elsewhere, the conversion of Metric to Imperial units is presented in *Appendix 1*.

Plate 13. Harvesting of green budsticks.

Plate 14. Harvesting of brown budwood.

row skipped after every six rows. This will have an initial stand of 91 428 plants and a final stand of 61 775 plants to a hectare. Workers with sharp pointed sticks, make shallow despressions for the germinated seeds to be slightly buried.

When the stock plants are vigorous and the top whorl of leaves are hardened, green budding is undertaken. Since all the stock plants are not ready for budding at once, four rounds are needed (*Plate 15a*). By the twenty-first day after the budding operation the plants are inspected and if successful they are broken at the top for identification. The budded plants are extracted by means of leverjack, four to five days later. Different types of leverjack are shown in *Plates 15b* and *c*. The polythene tape is left intact (*Plate 15d*) to protect the budpatch. The stumps are pruned off at 4 - 5 cm above the budpatch, the tap-root cut to 30 - 40 cm and the laterals trimmed to 10 cm.

Mini stumps. The mini stumps are raised from germinated seeds in the same way as described for the budded stumps except that the planting distance is 90 cm x 30 cm. A total of 35 830 stocks per hectare will be planted initially but a final stand of 29 652 plants will be budded for harvesting in about seven months after cutback. Mini stumps are obtained by allowing the bud to develop into a scion to a stage where about 60 cm of brown bark is obtained.

In preparing the mini-stumps for field planting, the tap root need not be 'tailed'. About ten days before extraction, the budding is pollarded (*Plate 16a*) at the brown wood region and just below a whorl of dormant buds. The cut end of the budding is treated with tree dressing (2 295 c grease or shell dressing) and the stem white-washed with hydrated lime (calcium hydroxide) (*Plate 16b*). Just before extraction for planting, the tap root is severed at 40 cm from the ground level (*Plate 16c*). After the stump has been pulled out from the ground, the laterals are trimmed off. *Plate 16d* shows the mini-stump ready for planting.

Stumped buddings. The technique in raising the stumped budding is similar to those described for budded stumps and mini-stumps, all of which are carried out in ground nurseries. The planting distance for stumped buddings is 90 cm x 90 cm which will have an initial stand of about 11 960 plants, and a final stand of 9 880 plants maturing for harvest in about 18 months from cutback. These plants can also be raised in nurseries originally planned for budded stumps. After cutback from green budding success, some plants are extracted as budded stumps leaving the rest to the planting distance of 90 cm x 90 cm with a stand of about 9 880 plants for harvest. The plants then will have 2.4 metres of brown wood

About one month before planting, all usable stumps are grouped roughly into 4 or 5 grades according to their girth sizes which normally vary from nine to fourteen cm. The stumps are subsequently transplanted in batches, to enable a better uniformity in field establishment.

Six to seven weeks before transplanting, a trench is cut along one side of the plant and the tap root is severed at a depth of 45 - 50 cm followed by half of the laterals. This process is called 'tailing' or root pruning (*Plate 17a*) after which the trench is filled back partially. Ten to fourteen days before field planting, the stump

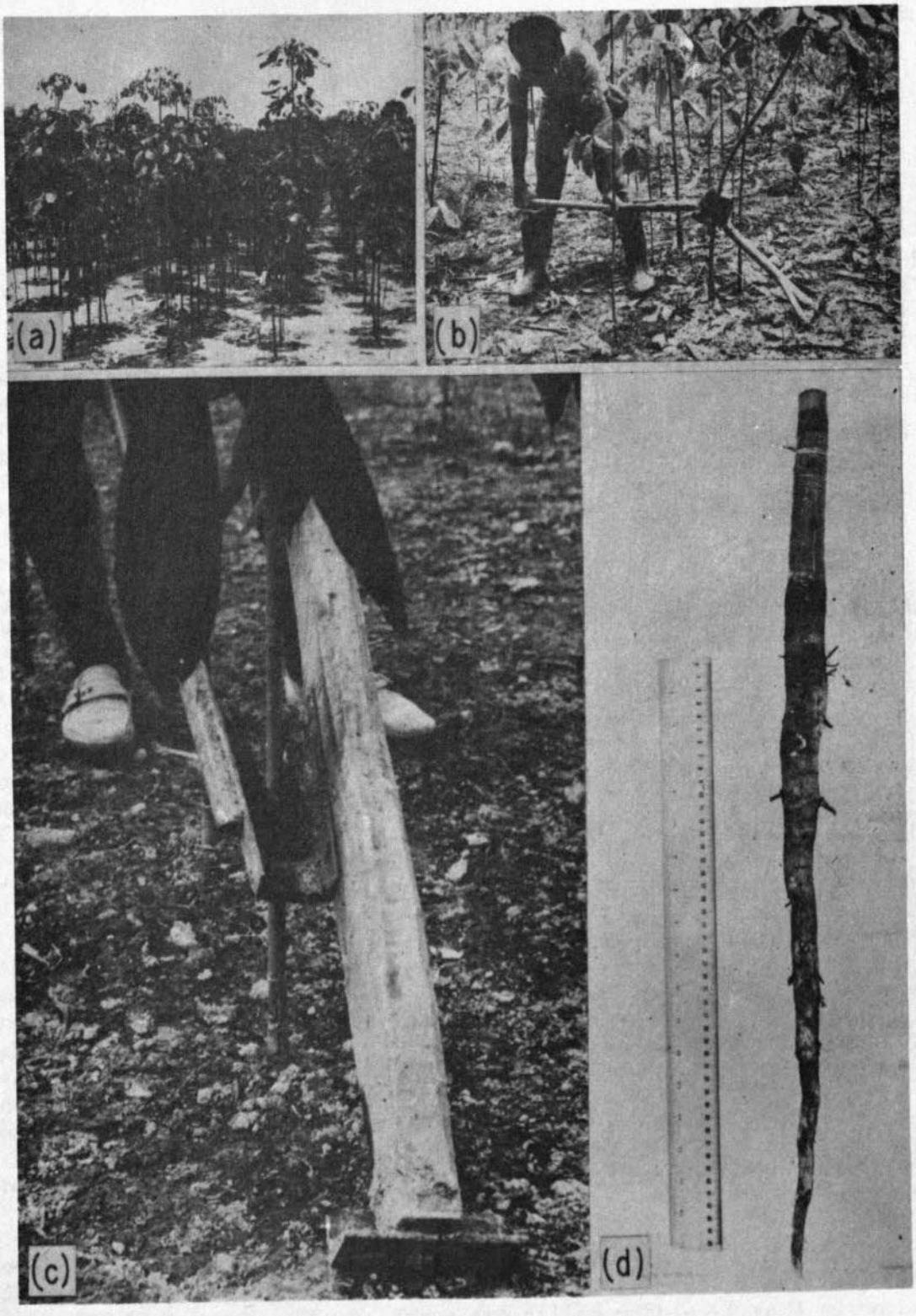

Plate 15. Preparation of budded stump

(a) Budded stump nursery ready for extraction
(b) + (c) Extraction with 2 types of leverjack
(d) Extracted budded stump with polythene tape intact.

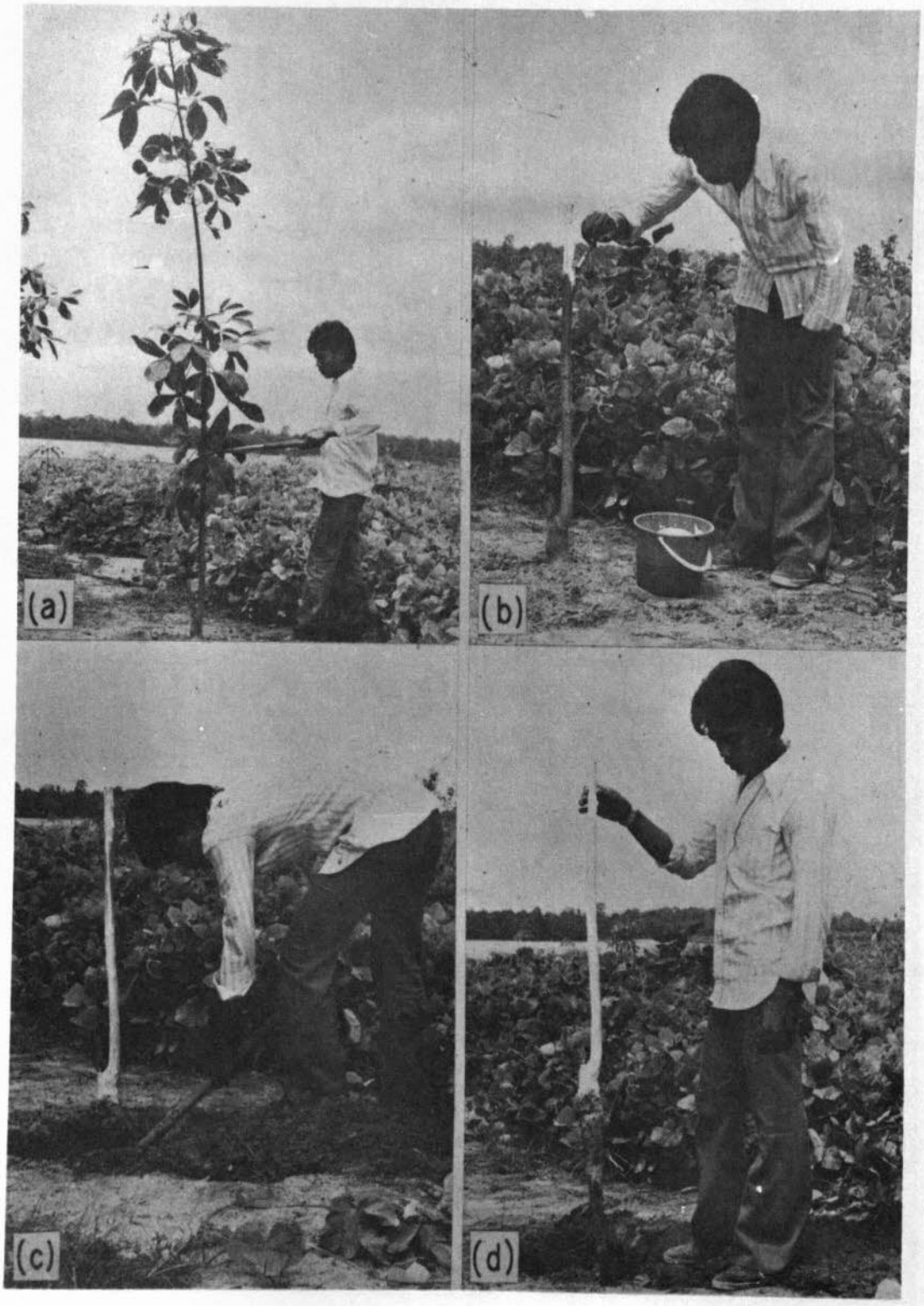

Plate 16. Preparation of mini stump

(a) Pollarding with a lopper
(b) White washing with hydrated lime
(c) Extraction
(d) Mini stump ready for planting.

is pollarded at a height of about 2.4 m of brown wood and just below a cluster of dormant buds (*Plate 17b*). The cut end is treated with tree dressing grease and the stump white washed immediately with hydrated lime (*Plate 17c*). *Plate 17d* shows an extracted stumped budding ready for field planting.

Stump extraction for transplanting should be carried out immediately after bud emergence with the buds being about 0.5 cm. Transplanting at a stage when the buds are much longer than this would cause a considerable amount of damage to the tender buds. On the other hand transplanting before bud emergence would result in greater failures.

Stumped three-part-tree. Pre-germinated seeds are planted in ground nursery at a planting distance of 90 cm x 90 cm and then green budded with the desirable trunk clone. After the basal budding, the trees are allowed to grow to about 3 - 3.6 m before they are green budded again at about 2.4 m above the ground level with the crown clone to ensure the development of a healthy canopy. This second stage of grafting is termed crown budding[37]. Three to four weeks after the budding, the budpatch is opened and the terminal whorl of leaves cut back to allow the crown bud to sprout and develop into a crown shoot.

After the establishment of the three-part-tree, a small trench is dug beside the plant so that the tap root and part of the lateral roots can be pruned (*Plate 18a*). The soil is refilled after pruning of roots is completed. About two months later, the plants are stumped in brown tissue just below the second cluster of buds on the crown shoot (*Plate 18b*). These stumps are then white-washed with hydrated lime (*Plate 18c*) and transplanted out to the field one week later as three-part stumps (*Plate 18d*). The timing of transplanting stumped three-part-tree to the field is similar to that adopted for stumped buddings.

Polybag buddings. The normal polybag buddings with two - three whorls of hardened leaves are raised in polybags of 23 cm x 41 cm layflat dimensions with 9 kg soil capacity. The density per hectare is 26 687 bags. Germinated seeds are planted in the polythene bags until they reach buddable age. After cutting back, the scion is allowed to grow two to three hardened whorls before planting out in the field. Alternatively, green budded stumps are removed as bare root material from the nursery ground and planted into the polythene bags. The budded stumps are then raised to two or three whorls before field planting.

For growing polybag plants efficiently in the nursery capable of advanced growth until six to seven whorl stage, large polybags of 38 cm x 64 cm layflat dimensions and 500 gauge with 23 kg capacity of soil are to be used. The polybags are filled with soil to 3 cm below the brim. Then the polybags are arranged to prevent self shading or competition for light among the plants. They are positioned in trenches dug 20 cm deep. The dug-out top-soil are mounded around the

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[37]Yoon, P.K. (1972) Technique of crown budding. Kuala Lumpur: *Rubber Research Institute of Malaya.*

Plate 17. Preparation of stumped budding

(a) 'Tailing'
(b) Pollarding
(c) White washing with hydrated lime
(d) Stumped budding ready for planting.

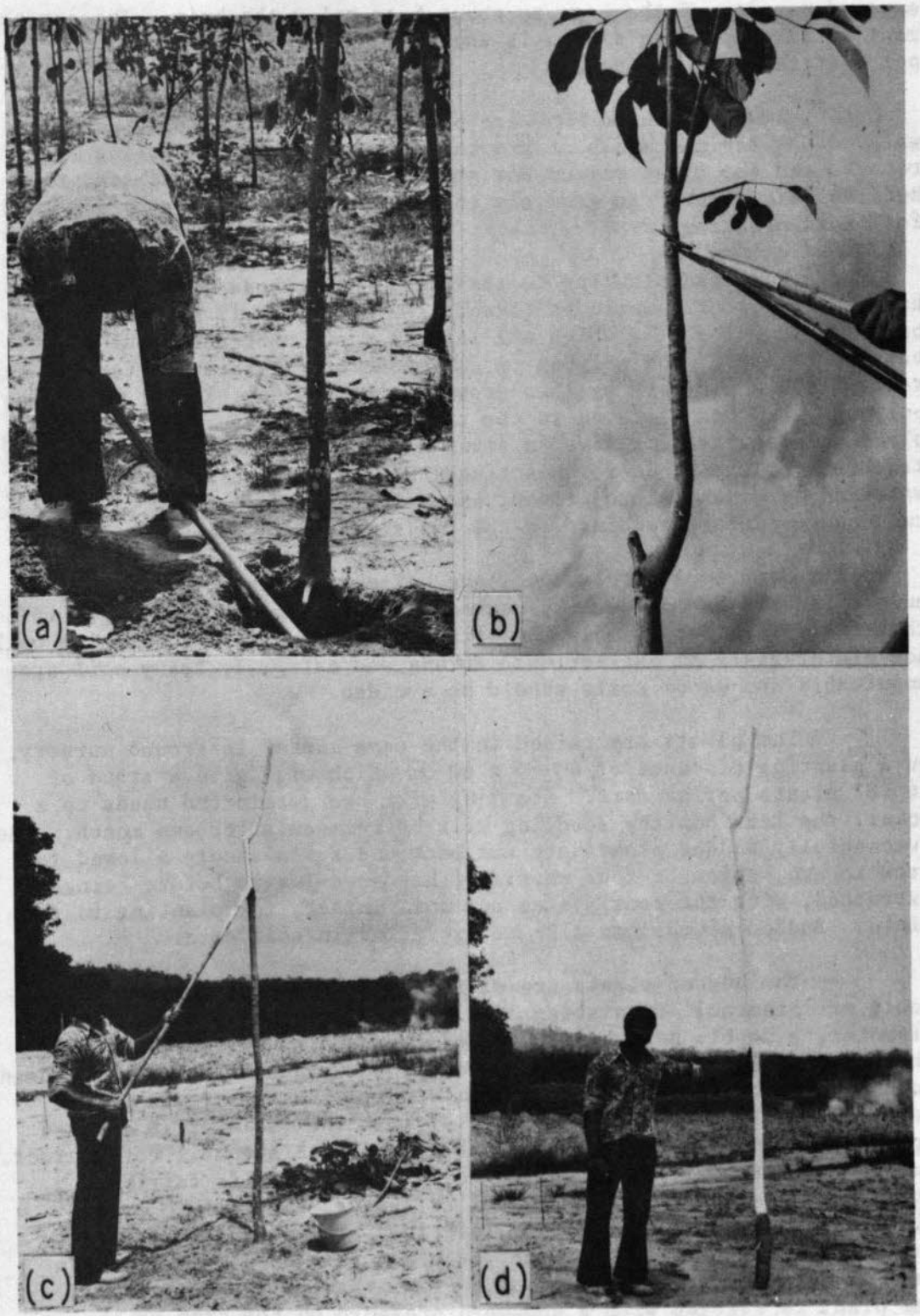


Plate 18. Preparation of stumped three-part-tree

(a) 'Tailing'
(b) Stumped just below the second cluster of buds
(c) White washing with hydrated lime
(d) Stumped three-part-tree ready for planting.

exposed portion of the bags to about 6 cm below the brim. The arrangement of large polybag plants is shown in *Figure 4*. The actual density per hectare is 17 940 bags.

Two germinated seeds are planted into each polybag and then watered. After one month of growth the less vigorous seedling is removed and the other raised for green budding. After cutback, the buddings are allowed to grow six to seven whorls before they are ready for field planting.

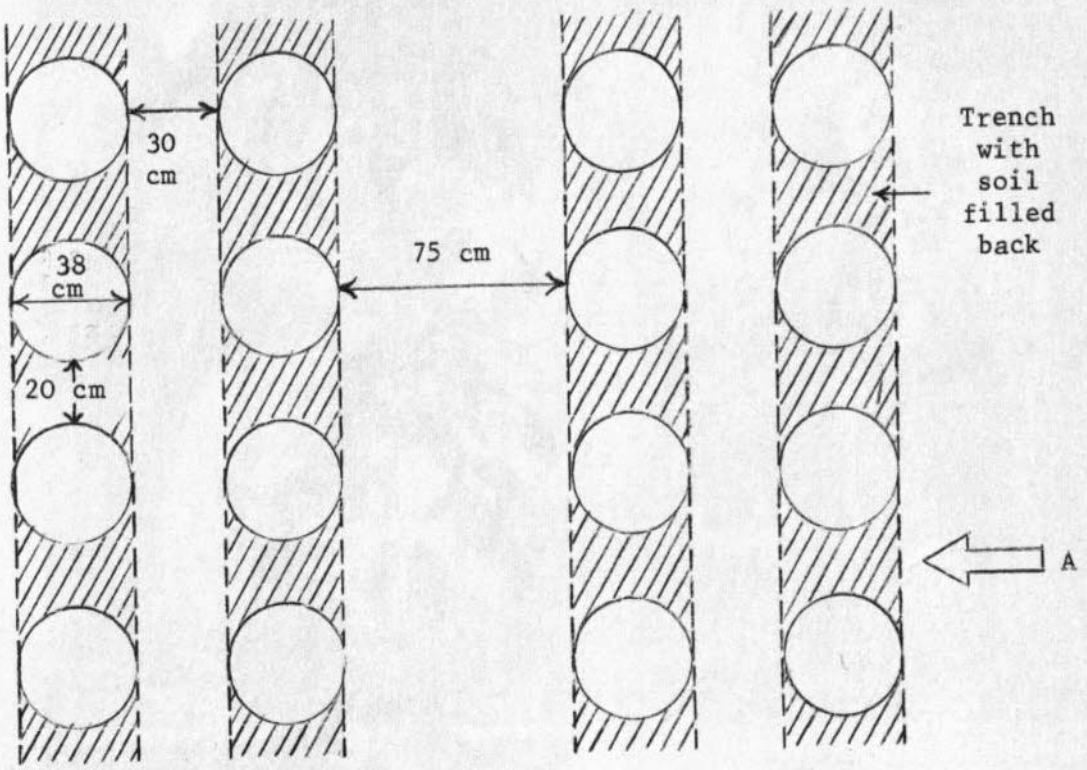
For transplanting to the field, only those plants with hardened top whorls would be taken. The mounded soil around the bag is removed, during which all lateral roots protruding out of the bag are severed. The polybag is taken out of the trench after the tap root, which would have by then grown out of the bag, is cut off. The polybags are then replaced in the trenches or transferred to a shady place and retained for five to seven days to overcome shock before taken out to the field for planting. During this period, regular watering is essential to prevent excessive wilting. *Plate 19* shows two and five whorl buddings in the two sizes of polybags.

Soil core whorled buddings. The soil for this type of nursery should be more easily worked. Soil cores are successful if there is sufficient clay in the soil to produce a firm core which will not disintegrate on extraction. Strong and extremely heavy soil are unsuitable and sandy soils should be avoided.

The plants are raised in the same manner in ground nursery, on a planting distance of 60 cm x 60 cm which will give a stand of 26 687 plants per hectare. Starting with two germinated seeds to a point, the less healthy seedling will be removed after one month. The successfully budded plants are cut back and scion shoots allowed to grow to two, three or four whorls of hardened leaves before being extracted, with the root system and soil intact, for planting in the field. Budded stumps can also be extracted in soil core.

The budded plants are extracted by means of the extraction tools or 'plantool' consisting of a cylinder with varying internal diameter, a double head hammer, an ejector and an extractor fork. The cylinder is inserted from the top of the plant and then positioned to be driven by the double head hammer until its arms reach ground level (*Plate 20a*). With the extractor fork the cylinder is levered upwards (*Plate 20b*) and the plant is lifted with the soil core intact. In the case of four whorl budding where the taproot is fairly long, it may be necessary to hold the collar against the soil to avoid slipping of the soil core during levering. The protruding taproot is cut off and the cylinder with the plant is placed on the piston head of the ejector with watering to firm the soil. (*Plate 20c*). The plant is ejected with a downward pressure on the arms of the cylinder. The soil core plant is then wrapped in newspaper or polythene sheets, and tied with twine (*Plate 20d*). Use of soil core material is not practised for large scale planting, though they are good for supply purposes. However, estates of about 100 ha have been established without much problem.

Table 12 gives the conversion of nursery hectare to field hectares for the different types of planting materials.



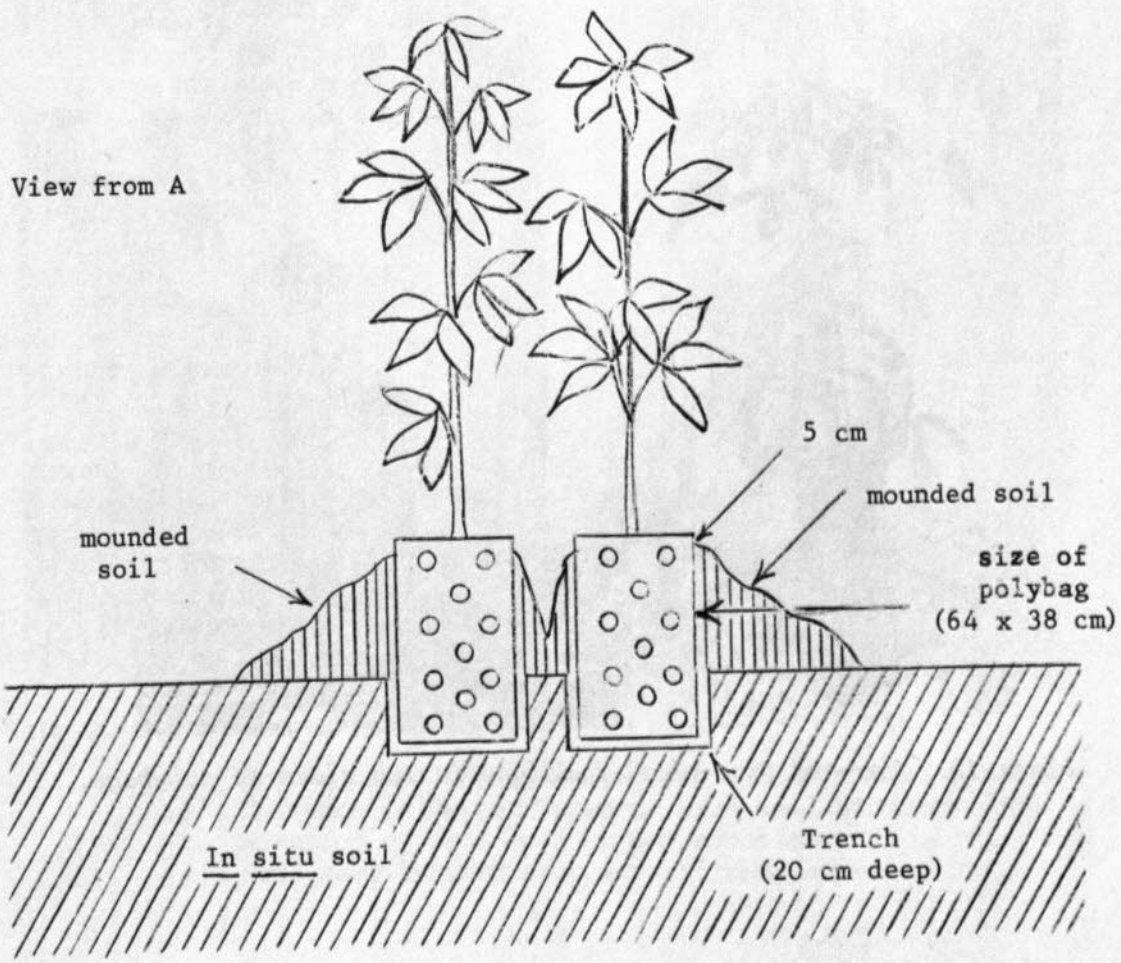


Figure 4. Placement of polybags in Nursery

Plate 19. Two-and five-whorl buddings in two sizes of polybags.

Plate 20. Soil core whorled budding

(a) Driving down the cylinder with a double headed hammer
(b) Cylinder is levered upwards with the extractor fork
(c) Watering of soil core before ejection
(d) Soil core budding wrapped with newspaper.

TABLE 12
CONVERSION OF NURSERY HECTARE TO FIELD HECTARE
FOR DIFFERENT TYPES OF PLANTING MATERIALS

Planting materials	*Nursery* *Spacing*	*Density* *Initial*	*Final*	*Field hectares at stand per hectare*		*Remarks*
Budded stumps	(60 x 15 cm) 6/1.2 m/(60 x 15) 6	91 428	61 775	139 ha	445/ha	-
	(2 x ½ ft) 6/4 ft (2 x ½ ft)6	(37 000)	(25 100)	(139 acres)	(180/acre)	-
Mini stumps	90 x 30 cm	35 830	29 652	75 ha	395/ha	-
	(3 x 1 ft)	(14 500)	(12 000)	(75 acres)	(160/acre)	-
Polybag 2 whorls	60 x 60 cm	-	26 687	67½ ha	395/ha	
Soil core buddings	(2 x 2 ft)		(10 800)	(67½ acres)	(160/acre)	-
Large polybag 7 whorls	(30 x 20 cm) 75 (30 x 20 cm)	-	17 940	45 ha	395/ha	-
	(1 x 2/3 ft) 2½ ft (1 x 2/3 ft)	-	(7 260)	(45 acres)	(160/acre)	-
Stumped budding	90 x 90 cm	11 960	9 880	26 ha	370/ha	-
Stumped 3-part-tree	(3 x 3 ft)	(4 840)	(4000)	(20 acres)	150/ha)	-
Source bush	120 x 120 cm	6 721	6 178	98 840 budsticks/ha/year		Four rounds per year
	(4 x 4 ft)	(2 720)	(2 500)	(40 000 budsticks/acre/year)		over 8 years
Brown budwood	90 x 60 cm	17 940	14 826	49 420 yd. sticks/ha/round		One round per year
	(3 x 2 ft)	(7 260)	(6 000)	(20 000 yd. sticks/acre round)		over 5 years

Post Harvest Handling and Distribution of Planting Materials

After selecting the most favourable season for planting, the object of good planting technique is to establish the material with the minimum setback and loss. Proper post harvest handling and transportation is essential when despatching rubber planting materials in order to preserve their viability and vigour. It is also essential to provide adequate and durable labelling for all materials consigned.

Seeds. If fresh seeds are required, collection rounds must be frequent, once in every two days. The freshly collected seeds are kept spread out in a cool shaded place before packing into gunny sacks, cartons or wooden boxes. Seeds can be despatched either germinated or ungerminated.

Germinated seeds can be despatched in cartons of size 36 cm x 33 cm to accommodate 1 100 seeds. The inner sides of the cartons are lined with damp aged sawdust (85% moisture by weight). The layers of germinated seeds are separated by sawdust to prevent the breaking of the radicles. The germinated seeds must be despatched as quickly as possible by road, rail or air, and the consignee must be advised to brush off the sawdust gently from the germinated seeds.

Ungerminated seeds are despatched in gunny sacks, cartons or boxes of size 86 cm x 36 cm for 5 200 seeds and on arrival at its destination they are spread out in a cool shaded place or set onto the germination bed immediately. Avoid stacking gunny sacks of seeds where heat can be generated to deteriorate the seeds.

Green budsticks. Green budsticks are preferably cut early in the morning. They are kept temporarily in polybags and in a cool shaded place for use in nearby fields on the same day. In the case of distant points the green budsticks are wax-sealed at both ends (*Plate 21a*), then packed in boxes or cartons of size 45 cm x 45 cm x 45 cm and 45 cm x 45 cm x 22 cm for 400 and 200 sticks respectively. The carton is lined with damp aged sawdust (40% moisture) and the layers of green budsticks are separated by the sawdust (*Plate 21b*). Green budsticks may be stored in this way up to six days. The carton is sealed with adhesive tape (*Plate 21c*). On the top is written the name and address of the consignee, together with the amount of budwood and the clone in durable ink. It can be consigned by rail, road and air.

Brown budwood. If the budwood are to be used on the same day in nearby fields, the budwood can be carried in a polythene bag or they can be rolled up with a cut-out gunny sack. Certain procedures are to be followed in cases where the budwood has to be despatched elsewhere. Brown budwood are harvested from the nursery into lengths of about 90 cm with the two cut ends dipped in melted wax to prevent drying out. This is usually done in the morning. They are then packed into wooden boxes of size 105 cm x 45 cm x 45 cm sufficient to accommodate 60 yards. The boxes are lined with damp sawdust and the layers of budwood are also separated by sawdust. The boxes are despatched by lorry, trailer, bus or train to the consignee.

Plate 21. Packing of green budsticks for transit

(a) Waxing of budsticks
(b) Budsticks being packed in a carton
(c) Carton sealed with adhesive tape.

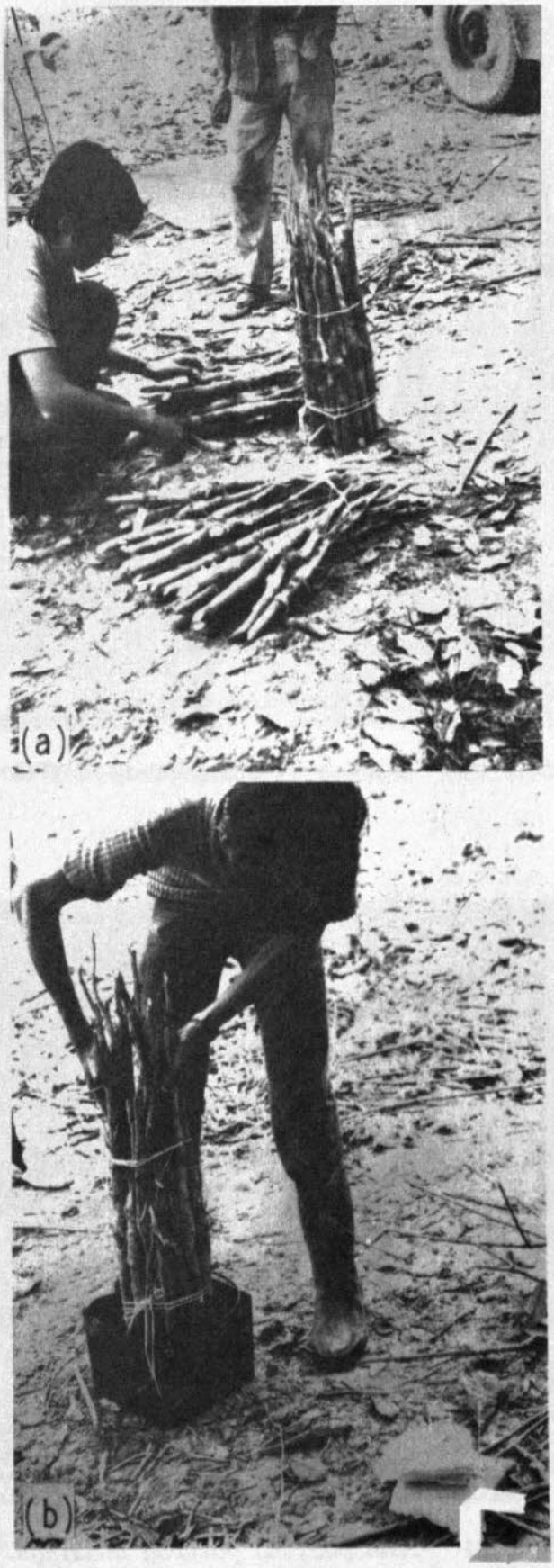


Plate 22. Handling of budded stumps

(a) Bundling of extracted stumps
(b) Cut ends of stumps are dipped in wax

Plate 23. Loading of stumps onto trailer

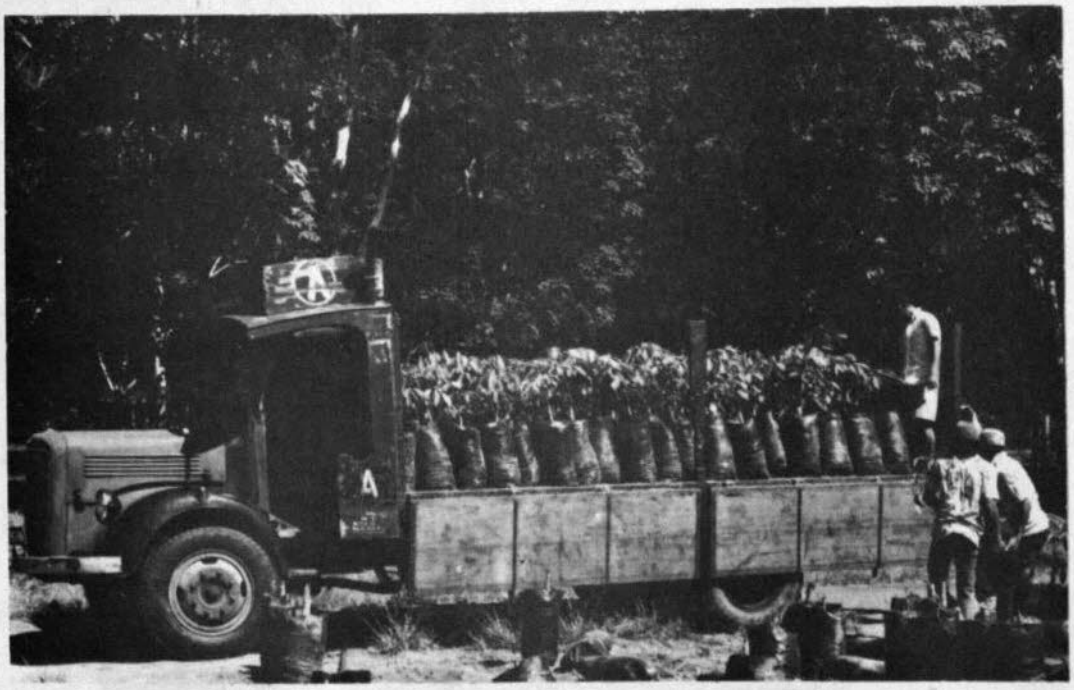


Plate 24. Transporting polybag buddings.

Plate 25. Soil core budding carried in a metal half-cylinder.

Plate 26. Watering of soil core buddings by knapsack sprayer.

Budded stumps. After the budded stumps are extracted with the lever jack and ready for field planting, they are tied into bundles of twenty-five and fifty (*Plate 22a*) for despatch by land rover, lorry, bus or train. The cut end of the budded stumps are dipped in melted wax to protect them (*Plate 22b*). The wax can be dyed to identify the clone.

Mini stumps. After the mini stumps are pulled out with the bare hands and after the roots are pruned, they are bundled into twenty-five and fifty depending on whichever is preferred. They are then despatched by land rover, lorry, bus or train as with budded stumps.

Stumped buddings. After extraction of the stumps, the roots are inspected for root disease infection and where indication of root disease exist, they should be treated. They are then loaded onto the lorry or trailer which can accommodate the stumps lying flat down, head to tail to each other on the vehicle. Loading should be done with due care, holding the central portion of the stem only. The stumps are to be separated from each other with dry lallang or other equivalent material to prevent bruising while on transit (*Plate 23*). They should be conveyed to the fields in the late afternoon or evening for unloading the next morning and immediate planting in the fields to minimise loss. It is important that field planting be done only during the wet season.

Polybag buddings. Two to three whorl polybag buddings can easily be loaded onto the lorry or trailer (*Plate 24*) and placed close to each other to prevent the plants from falling over. The polybag plants should be loaded carefully and arranged to avoid excessive movement of the bags during transport.

As for large polybag plants which would be about 2.5 m high, it is advisable to use wooden scaffoldings on the trailer to support the aerial portions of the plants and to prevent damage during transit. As each bag may be too heavy for one person, it is advisable to transfer the bags in specially constructed boxes with handles. This would enable about three plants to be carried by two men. Due attention should be paid to timing of transplanting as a drought period of five to ten days immediately after transplanting would result in severe losses.

Soil core whorled buddings. After extraction, the soil core buddings can easily be loaded onto the lorry or trailer and placed close to each other to prevent the plants from falling over. Transfer of these plants to the field is best done in the morning or evening to avoid leaf scorch.

In handling soil cores, they can be carried individually in metal half-cylinders which give support and prevent breakage (*Plate 25*). Large soil core buddings may require shade for a few days before planting out, should weather become unfavourable. Watering of the leaves by means of knapsack sprayer is recommended to cut down transpiration and to avoid wetting of the paper wrapping (*Plate 26*).

CHAPTER VII

NURSERY COSTINGS

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NURSERY COSTINGS

The cost figures reported here are gathered from large nurseries all over the country. The main tables express the cost in dollars and cents based on current prices of labour and material. Wherever possible, the actual input of labour and material is given in the text. This facilitates future cost estimation should the price of labour and material change considerably.

Land Clearing

This operation is usually given out on contract to specialised contractors who have the expensive heavy equipment necessary for mechanical clearing. Because nursery cultivation is intensive agriculture, it is best to clear the land properly at the onset. If possible, all large stumps should be completely removed. Thus the cost incurred may be slightly higher than those encountered in normal rubber cultivation.

The cost of clearing will vary with the type of existing vegetation. The three common types and their corresponding costs are given below:

Clearing cost by contract	*Cost ($/ha)*
Primary jungle	988
Secondary junle	198 - 988
Old rubber stand	284

Although listed as primary jungle, the jungle land normally cleared for rubber cultivation would have had their timber (larger trees) extracted earlier on. The result of this is the establishment of a much thicker undergrowth than that normally found in virgin jungle. This undergrowth raises the cost of clearing as additional procedures such as underbrushing, will have to be carried out.

The large variation in the cost of clearing secondary jungle is due to the different types of blukar encountered. If the under-growth is extremely thick and there are large stumps left to be cleared, the cost may be as high as that of primary jungle. If the vegetation is not so thick (recently abandoned land), the cost may be as low as $198 per hectare.

In clearing old rubber stands, the cost again will vary depending on the value of the timber (normally used for firewood, charcoal or wood chips) to be extracted. If the field is easily accessible from the main road, the contractors will cart out the timber and charge a lower cost for clearing. The local demand for rubber wood also influences the clearing rates. There has been instances where clearing is done free by the contractor. However, these are isolated cases where the field is both near the main road and the prevailing price of rubber wood is good.

In the case of nursery land, the cost quoted, at $284 per hectare, assumes that no rubber wood is removed by the contractor and all traces of roots and small branches are burnt. This will reduce the incidence of root diseases later on.

The actual operation involved in clearing includes felling, stacking, burning root (buttresses), clearing and a second round of burning.

Fencing

Fencing may be required to keep out both animals and trespassers. The normal type of fencing consists of four strands of barbed wire strung at 0.3 m interval on hard wood timber post planted at 3 m interval. In addition, a wire netting of 2.5 cm mesh and 0.9 m high is fitted to prevent small animals from crawling under the fence. The cost of every 20 m of this type of fencing is shown below:

Break-down of Fencing Cost

Item	*$*
Barbed wire (4 strands)	7.04
Wire netting (0.9 m high)	17.60
Timber post ($1.10 each)	7.26
Labour	3.00
Total cost of 20 metres fencing	$34.90

Cultivation

Land cultivation is also normally given out on contract. The main cost items are as follows:

Break-down of Cultivation Cost

Item	*Cost ($/ha)*
2 rounds of ploughing plus 1 round of harrowing	148.30
1 round of rotovation	49.40
628 kg of CIRP	154.40
252 kg of Mag. lime	13.60
Total cost	$365.70

These operations in land cultivation have to be repeated every time a second round of planting is required. Thus in the case of budded stump production all these operation are repeated each year after harvest. In the case of bush nursery the cultivation processes need not be repeated for ten years when the source bushes are replanted.

Seed Germination

Seeds are purchased in sacks of 60 kg. Each sack contains about 13 000 seeds and costs $30. These seeds should be at least 80% viable.

The cost of construction of seed beds will be based on the type described in Chapter VI, with a length of nine metres. Such a bed will need two manday of labour to construct and to loosen the soil. This bed can germinate three rounds in one season.

When the beds are ready, the germination operation is carried out by a contractor at a rate of 0.75 ct per successfully germinated seed. The costs incurred in germination is summarised in *Table 13.*

TABLE 13
COST OF GERMINATION BED

Item	*Cost ($)*
Germination bed (labour and materials)	10
Labour cost to fill the bed or loosen soil	5
Construction of shade: 10 posts	2
cross-sticks	2
nipah leaves	2
ratan strips	0.5
labour	2
Total cost per bed of 9 m x 0.9 m	23.50

Each bed covers 8.4 sq. metres and at the rate of 1 196 seeds per square metre, each bed can germinate 10 000 seeds at a time. In each season, three germination rounds can be carried out giving a total of 30 000 seeds for each bed.

The cost of germinating a seed is summarised in *Table 14.*

TABLE 14
BREAK-DOWN COST IN TERMS OF EACH GERMINATED SEED

Item	*Cost (ct)*
Seed	0.29*
Seed bed	0.10*
Contract labour for germination operations including watering and planting	0.75
	1.14

*Assuming 80% viability of the seeds

The total cost of a germinated seed planted into the ground is 1.14 ct. This includes cost of seed, cost of germination bed and

shade structures and all the labour requirements at each stage.

Budded Stump Production

The germinated seeds are planted in the ground in rows 0.6 m apart. The distance within row is 0.15 metre. After every six rows, a gap of 1.2 m is left vacant. This will give an initial density of about 91 428 points to a hectare.

Budding is done on contract at 5.5 ct per success and this includes the cost of the polythene strips. The seedlings are budded in three or four consecutive rounds.

The extraction cost varies slightly depending on the size of the budded stumps. Extraction by means of lever jack costs $40 each. Given on contract, extraction cost is $14 per thousand budded stumps (or 1.4 ct per stump). This includes extraction, cutting off the top, trimming the roots, waxing, bundling and loading.

In terms of actual labour requirements, one contract labourer can harvest about 1 000 stumps per day working for long hours (7 a.m. to 5 p.m.). This refers to stumps that are not overgrown.

Also included in the cost on some nurseries, is the expenditure incurred on thinning and pruning. This may amount to $29.7 to $59.3 per hectare. If leaf disease spraying and pest control is carried out, a further charge of $49.4 per hectare has to be added on.

Basing on these costs and working on the assumption that 61 775 budded stumps are finally harvested from each nursery hectare, the approximate cost of production per unit budded stump is computed in *Table 15*.

TABLE 15
BREAK-DOWN COST OF PRODUCTION FOR EACH BUDDED STUMP
(ON PER HECTARE BASIS)

Item	*Cost (ct)*
Land clearing $988.00 ÷ 10 years	0.16
Land cultivation - $198	0.32
CIRP (628 kg at $250 per m ton)	0.25
Mag. lime (251 kg at $55 per m ton)	0.02
Germinated seed	1.14
Weeding ($222 + $185)	0.66
Fertiliser (2337 kg at $846 per m ton)	3.20
Transport for all the fertilisers (Estimated at $49.4 per ha)	0.08
Labour for fertiliser application ($37/ha)	0.06
Budding	5.50
Extraction until loading	1.40
Pest and disease ($49.4/ha)	0.08
Thinning and pruning ($49.4/ha)	0.08
Budwood	2.00
Total	14.95

Budwood Production

Both brown budwood and green budsticks are popular among smallholders. There is a preference for brown budwood because of its more hardy nature. Green budsticks on the other hand are more delicate and easily damaged.

Both types of source bushes can be established from budded stumps. For the purpose of costing below, both types of source bush nurseries are assumed to be established by this method. This will shorten the establishment period and ensure a more uniform stand.

Green Budstick Production

The cost of 6 721 budded stumps at the rate of 15 ct per stump amounts to $1 008.15 of planting material per hectare. Mechanical holing by tractor costs about 3.5 ct per hole. This amounts to $235.24 per hectare. Into each planting hole 113.4 gm of CIRP are added before the planting takes place *i.e.* 763 kg of CIRP per hectare. The labour incurred for planting the budded stumps is 4.0 ct per point. This is higher than brown budwood bushes because of the wider spacing.

Eventually, a total of about 6 178 points per hectare will be producing budsticks. The rate of production from the second year onwards is 98 840 budsticks per hectare per annum for the next eight years.

The cost of establishing such a hectare of source bush nursery is summarised as shown in *Table 16*.

TABLE 16
COST ITEMS IN ESTABLISHING ONE HECTARE
OF GREEN BUDSTICK NURSERY

Item	*Cost ($/ha)*
Land clearing	988.40
Land cultivation (plus CIRP + Mag. lime)	365.70
CIRP (763 kg at $250/ton in planting hole)	187.52
Budded stumps: 6 721 at 15 ct each	1 008.17
Holing at 3.5 ct per hole	235.24
Planting at 4.0 ct per point	268.84
Weeding for 1 year (8 rounds)	988.40
Manuring for 1 year	2 333.12
Pruning for the first year	123.55
Labour and transport of fertilisers, budded stumps, etc.	617.75
Total	**7 116.70**

The total establishment cost (fixed cost) is $7 116.70. This is spread over a period of eight equal productive years giving an average fixed cost of $889.60 per productive year.

After establishment, the nursery has to be maintained and harvesting carried out. Weeding cost for bush nursery amounts to $37.10 per hectare per month with an additional $7.41 per hectare for pest and disease control. Fertiliser is broadcasted at 125.5 kg per hectare per round. A normal yielding nursery may need ten rounds of manuring per year.

Harvesting of budstick is usually done by contract labour at the rate of 0.5 ct per stick. This includes cutting, cleaning and waxing. The card-board box costs about $1.40 and the packing charge is 50 ct per box of 450 budsticks. An additional charge of 30 ct per box is allowed for sawdust.

The above items are all recurrent cost (variable cost) of production of 98 840 budsticks per hectare. These are itemised in *Table 17*.

TABLE 17
RECURRENT COST OF PRODUCTION OF 98 840 BUDSTICKS

Item	*Cost ($/ha)*
Weeding	444.78
Pest and disease	88.96
Fertilisers	1 045.23
Harvesting labour	494.20
Cardboard boxes	307.51
Packing labour	109.83
Sawdust	65.81
Labour for application of fertiliser	123.55
Transport of budwood and fertiliser	494.20
	3 174.07

Thus by combining the average fixed cost per year and the annual variable cost, the total cost per year is $3 174.07 + $889.59 = $4 063.66. This is the cost of producing 98 840 budsticks per year. Thus the cost of production of one budstick is 4.1 cents.

Brown Budwood Production

From an initial density of 17 940 points per hectare about 14 826 points will eventually be yielding. The establishment cost is more or less similar to that of green source bush nursery and is summarised in *Table 18*.

TABLE 18
COST ITEMS IN ESTABLISHING ONE HECTARE
OF BROWN BUDWOOD NURSERY

Item	*Cost ($/ha)*
Land clearing	988.40
Land cultivation (plus CIRP and Mag. lime)	365.71
CIRP (2 034 kg at 112 gm/planting hole)	500.55
Budded stump (17 940 points)	3 587.90
Holing at 3.5 ct per hole	627.88
Planting at 2.0 ct per hole	358.79
Weeding for 1 year (8 rounds)	988.40
Manuring for 1 year (241 gm/point)	3 599.41
Labour for fertiliser application	123.55
Transport of fertilisers, budded stumps, etc.	617.75
Total	11 758.34

The cost includes only the fixed cost items. Once production begins, the harvesting and maintenance cost (variable cost) will be incurred. Harvesting is given out on contract at 1.5 ct per yard inclusive of waxing. The budwood is packed 60 yards to a box. The packing charge is $1.50 per box with an addition of 50 ct for sulphur dusting. The box itself costs $4.00 each.

The rate of production varies with age. *Table 19* summarises this in yards per harvest. Altogether five harvests can be obtained before the stumps are replanted.

TABLE 19
RATE OF PRODUCTION FROM ONE HECTARE
OF BROWN BUDWOOD NURSERY

Item	*Amount (yards)*
1st harvest	24 710
2nd harvest	37 065
3rd harvest	61 775
4th harvest	61 775
5th harvest	61 775
Total	247 100

The recurrent cost (variable cost) is summarised in *Table 20*. The assumption that 49 420 yards of brown budwood is harvested at each round is made to simplify the cost per unit calculation.

TABLE 20
THE BREAK-DOWN OF THE VARIABLE COST
OF PRODUCTION OF BROWN BUDWOOD

Item	*Cost ($/ha)*
Harvesting	741.30
Weeding	247.10
Packing (labour)	1 235.50
Sulphur dusting	411.84
Boxes	833.54
Fertilisers (6 rounds at 1 oz per point)	2 099.80
Labour for fertiliser application	123.55
Pest and disease	88.96
Transport charges	1 482.60
Total	7 264.19

Based on the 49 420 yards per round and since there are five rounds of harvest, the fixed cost (establishment cost) average out to:

$$\frac{\$11\ 758.34}{5} = \$2\ 351.67 \text{ per round per hectare.}$$

The variable cost for each round of harvest from *Table 20* is $7 264.19. Thus the total cost of production is:

$$\$7\ 264.19 + \$2\ 351.67 = \$9\ 615.86$$

This is the cost of producing 49 420 yards of brown budwood. Therefore the cost per yard is:

$$\frac{\$9\ 615.86}{49\ 420} = 19.5 \text{ ct per yard.}$$

Mini Stump Production

Essentially, the cultivation practices involved in mini stump production resemble that of budded stumps except that the planting distance is 0.9 m by 0.3 m giving a density of 35 830 points to a hectare. The final harvest is about 29 652 points to a hectare. The cost incurred are summarised in *Table 21*.

TABLE 21
BREAK-DOWN COST OF PRODUCTION FOR EACH MINI STUMP
(ON PER HECTARE BASIS)

Item	*Cost (ct/mini stump)*
Land clearing $988 ÷ 10 years	0.33
Land cultivation $198	0.67
CIRP (629 kg at $250/ton)	0.52
Mag. lime (252 kg at $55/ton)	0.05
Germinated seed	1.14
Weeding (until budding $408)	1.38
Fertiliser (1054 kg at $846 per ton per hectare of seedlings	2.95
Labour for fertiliser application ($37.10 per hectare)	0.13
Pest and disease ($49.40/hectare)	0.17
Thinning and pruning ($49.40/hectare)	0.17
Budding and cut-back	5.50
Budwood	2.00
Pruning of stock shoots ($20)	0.07
Weeding ($408)	1.38
Fertilisers (18 gm per point)	10.01
Labour for fertiliser application ($62 per hectare)	0.21
Pollarding, extraction and bundling	8.00
Transportation of fertilisers, etc. ($247/hectare)	0.83
Total	35.51

The cost per unit works out to be 35.51 ct, based on a harvest of 29 652 mini stumps per hectare.

Stumped Budding Production

Since these plants will be retained in the nursery for a longer period (eighteen months after cut-back) their planting distance is 0.9 m by 0.9 m giving a density of 11 960 points per hectare. At harvesting about 9 880 stumps will be left.

Based on this, the cost of production of these stumps are worked out in *Table 22*.

TABLE 22
BREAK-DOWN COST OF PRODUCTION
OF EACH STUMPED BUDDING

Item	*Cost (ct/stumped budding)*
Land clearing $988 ÷ 10 years	1.00
Land cultivation, CIRP and Mag. lime ($198 + 154.40 + 13.60)	3.70
Germinated seed	1.38
Weeding up to budding ($222.40 + 185.30)	4.13
Fertiliser up to budding	12.80
Labour for fertiliser application ($37.00/ha)	0.37
Budding and cut-back	5.5
Budwood	2.00
Stock shoots pruning ($23.70/ha)	0.25
Weeding ($148 + $247/ha)	4.00
Fertiliser (0.37 kg/point)	31.20
Pest and disease ($49.40/ha)	0.50
Pruning ($12.40/ha)	0.13
Tailing	4.41
Pollarding and white washing	8.82
Extraction	6.61
Transport of fertilisers, etc. ($247/ha)	3.33
Total	90.13

Thus the cost of production of one stumped budding works out to be 90.13 cents.

Stumped three-part-tree

In the case of stumped three-part-tree, the additional cost due to crown budding would include the cost of budwood, the operation itself and subsequent rounds of pruning the trunk shoots. Basing on $75 per hectare at $345 per hectare, the additional cost per point works out to be 19 ct, over that of producing a stumped budding. Thus the cost of production of one stumped three-part-tree is 19 ct + 90.13 ct = 109.13 cents.

Two-Whorl Polybag Buddings

The size of the polybag used is 23 cm x 41 cm (lay flat dimensions). Two germinated seeds are planted per polybag and later thinned to one for budding. After budding and cut-back, the plants are allowed to grow until two to three hardened whorls before transplanting into the field.

Table 23 gives the break-down cost of production of this type of planting material.

TABLE 23
BREAK-DOWN COST OF PRODUCTION
OF TWO-WHORL POLYBAG BUDDINGS

Item	*Cost (ct/polybag plant)*
Cost of polybag	2.93
Cost of filling the bag	2.50
Cost of soil (labour & transport)	1.25
Trenching	1.50
Placement of polybag in the trench	0.80
Cost of two germinated seeds	2.28
Cost of fertiliser application	0.06
Cost of weeding (before budding)	0.66
Cost of watering	8.59
Budding	5.50
Budwood	2.00
Watering	7.16
Weeding	0.79
Fertiliser	6.30
Labour for fertiliser application	0.12
Loading onto trailers	2.00
Total	47.39

Assuming a 95% success for the polybag plants, the cost per unit is inflated from 47.39 ct to 49.88 ct per polybag budding.

Large Polybag Buddings

The plant is raised in large polybags of 38 cm x 64 cm (layflat dimensions) and kept until six to seven whorls of leaves have hardened. After the bags have been filled and arranged, either germinated seeds or budded stumps can be planted in them. The other operations such as maintenance and budding remain the same.

In the case of using budded stumps, these stumps are extracted from the ground nursery and planted in the prepared polybags. The break-down costing will describe this type. The actual density per hectare is 17 940 bags. The break-down cost of production is given in *Table 24*.

Because of the intensive care for polybag plants, the success is good and the costing is based on a harvest of 17 940 plants from a planted hectare. If the success is 95% instead of 100%, then the unit cost of production will be inflated proportionately to 116.56 ct per polybag plant.

Soil Core Whorled Buddings

Buddings can be extracted in soil core when they have grown two to three whorls or more. Basing the costing on per field hectare, the cost per point is worked out as shown in *Table 25*. Cost for extraction tools is summarised in *Table 26*.

TABLE 24
BREAK-DOWN COST OF PRODUCTION
OF LARGE POLYBAG PLANTS

Item	*Cost (ct/polybag plant)*
Cost of polybag	21.65
Cost of filling the bag	10.00
Cost of soil (labour and transport)	5.00
Trenching	2.50
Placement of polybag in the trench	3.19
Cost of budded stumps	14.45
Transport of budded stumps	1.00
Planting at 1.5 ct each	2.00
Watering	21.48
Weeding ($222 + $309)	2.96
Fertiliser	23.40
Labour for fertiliser application	1.00
Root pruning and loading onto trailer	3.00
Total	111.63

TABLE 25
BREAK-DOWN COST OF PRODUCTION
OF SOIL CORE BUDDINGS

Item	*Cost ($/ha)*
Total cost to budded stump stage	59.25
Extra 36 gm fertiliser per point extraction stage @ $846 m ton	18.71
Cost of extraction including supplies 445/ha at 10 ct per point	44.50
Depreciation at $10 per field hectare	10.00
Repair, papers etc. 445/ha @ 5 ct per point	22.25
Total	154.71

The cost per point @ 395/ha for two to three whorl buddings is 39.1 cents.

TABLE 26
BREAK-DOWN COST OF EXTRACTION TOOLS ("PLANTOOL")

Item	*Cost ($)*
36 x 38 cm (internal diameter) cylinder 5 x $36	180
Double-head hammer	58
Ejector	56
Extractor fork	24
Whole set costs	318

The above cylinder is meant for budded stump extraction. For two-whorl buddings, 40 x 18 cm cylinders are used. For three-whorl and above, use 48 x 18 cm cylinders. Ten and twenty percent cost are added for 40 cm and 48 cm cylinders respectively.

In all the costings, the labour rate is assumed at $4.50 per man-day. The fertilisers used are Christmas Island Rock Phosphate at $250 per ton, Magnesium lime at $55 per ton and a complete fertiliser with soluble phosphate at $846 per ton. As these prices are subject to fluctuations, the actual price is given here so that proportional changes can easily be made to adjust to these changes.

Wherever possible, chemical weed control is practised to reduce the costs as manual labour gets more expensive. For example in stumped budding, manual weeding is carried out during the first four rounds after cutback and subsequently chemical spraying is introduced.

As far as possible, most of the tasks in nursery work is given out on contract on a piece-meal basis. This reduces the supervision required. In the costings, the cost of supervision is completely left out as it is more difficult to estimate the proportion of the Manager's time required to run the nursery.

Another item left out is the cost of fencing. Although given earlier, this item of cost is not included in computing the unit cost of production of the various materials. Fencing may not be necessary if the nursery is organised in such a manner that the source bushes (permanent feature) form a natural belt all round the nursery.

CHAPTER VIII

CONCLUSION AND RECOMMENDATIONS

CHAPTER VIII

CONCLUSION AND RECOMMENDATIONS

This report has considered the various aspects of nursery practice in the production of rubber planting materials. Information concerning the existing nursery conditions in the smallholding sector is presented here so that recommendations may be made to exploit the potentialities of nursery practices.

The planting materials used in smallholders' replanting programme are being supplied by five large RISDA nurseries located at various parts of Peninsular Malaysia. Their locations are shown in *Figure 5*.

The total production of the various types of planting materials for 1974 is given in *Table 27*. The last column shows the respective areas covered by each planting material.

TABLE 27
TOTAL PRODUCTION OF RISDA NURSERIES IN 1974

Material	*Quantity*	*Area covered (ha)*
Brown budwood*	669 041 yards	13 538
Green budstick**	2 773 726 budsticks	11 225
Budded stump***	4 323 737	8 749
Mini stump***	19 962	40
Stumped budding***	5 326	11
Total area		33 564

* 20 yards to a planted hectare
** 247 sticks to a planted hectare
*** 494 units to a planted hectare

Brown budwood is used in the greatest quantity followed by green budsticks. Budded stump is a popular material accounting for 8 749 hectares. The remaining two types of materials, mini stump and stumped budding account for only 40 and 11 ha respectively.

From the table, it is seen that the first three types of planting material (brown budwood, green budstick and budded stump) account for 99.85% of the total used. The mortality rate of these material is lower and they provide a more flexible planting programme as they are less affected by delay in establishment. The more advanced

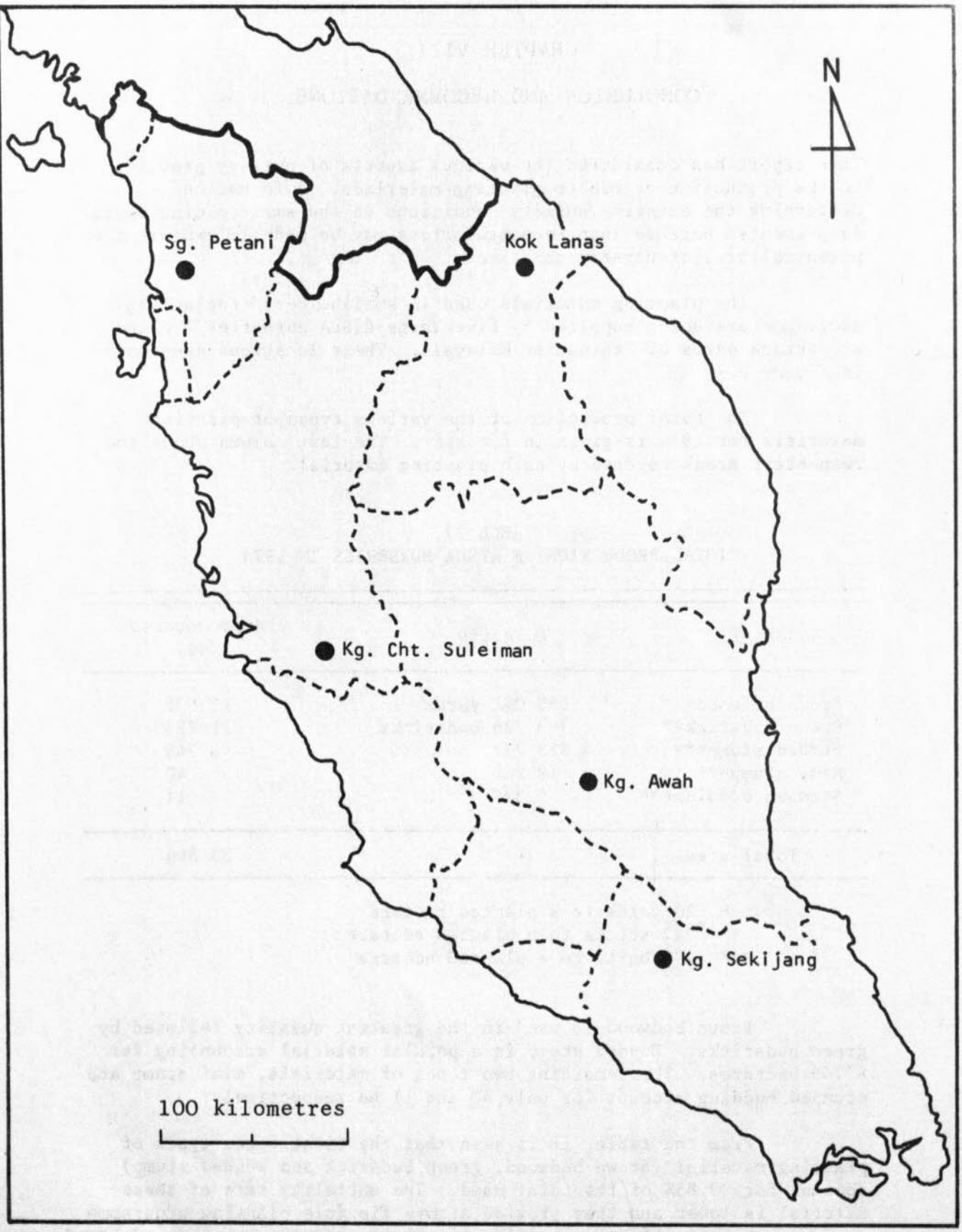

Figure 5. The five central nurseries of RISDA.

planting materials such as mini stumps, stumped buddings, stumped three-part-tree and large polybag plants are hardly utilised by smallholders. This can be attributed to various reasons.

The more advanced materials, being more bulky, need better handling during transportation and usually the vehicle space required is more. This increases the transport costs considerably, especially over long distances when this cost makes the operation prohibitive.

The lack of large access roads (for lorry or land rover) right up to the replanting field also eliminates the use of advanced materials. Some holdings are only accessible to motor-cycles and bicycles and if there are no bridges built over streams, then these holdings may not be reached by even these small vehicles.

The cost per unit of advanced planting material is higher and the smallholder is thus reluctant to use it as every unsuccessful unit represents a larger loss to him.

In the case of mini stumps and stumped buddings, more intensive post-planting care is necessary to ensure good success. Such techniques will be new to the smallholder and he may feel uncertain about attempting using these materials.

Most of these problems faced by the smallholder trying to adopt advanced planting materials can be solved. For example, in the case of the lack of previous experience in using advanced planting materials, intensive extension work before the commencement of the replanting programme will result in a higher acceptance rate.

The establishment of more nurseries to supply planting materials will reduce the distance the materials have to cover to reach the smallholder. This in turn cuts down the cost as well as the mortality rate.

For the inaccessible holdings, more secondary roads and bridges will aid in modernising these holdings. Easier access will mean more frequent visits by extension workers too. The transport of advanced planting materials will be possible and subsequently the product from these holdings can be easily marketed.

To reduce the period of immaturity of rubber, smallholders should be encouraged to establish advanced planting materials in preference to field budding. To reduce the problems of transportation, inaccessibility, high mortality and low acceptance rate, the practice of setting up a nursery in the interrows of a rubber replant should be encouraged. This nursery holding will act as a nucleus to supply surrounding holdings with planting materials for the next three years. The neighbouring holdings will have to be first surveyed and the area due for replanting determined. Close supervision by field extension workers will be of the utmost importance. The neighbouring smallholders may be encouraged to help in establishing the nursery while they still tap their old stands. Thus it is possible to time the various operations in such a way that the period during which the land is unproductive will be minimised. This nursery holding should preferably be centrally placed on good soils. The smallholder involved in such a project should be a progressive farmer.

The planting distance for this nursery holding should be such that the interrow area is large enough for cultivation. A spacing commonly adopted is 9.1 m x 2.4 m giving a space of 6.7 m wide in the interrow for establishing the nursery. This works out to be about 73% of the total land area available for nursery work. Thus the production per unit area will be reduced proportionately too. If the between row distance is reduced, the percentage of available interrow space decrease further. *Table 28* gives some of the common planting distances and their respective land availability. (A gap of 1.2 m is allowed on either side of the tree row).

TABLE 28
AVAILABLE LAND AT VARIOUS PLANTING DISTANCE

Planting distance (m)	*Percentage land available (%)*
9.1 x 2.4	73
6.7 x 2.4	64
6.1 x 3.7	60

The interrow nursery space can be used to produce three rounds (harvests) of budded stumps, two rounds of mini-stumps and large polybag plants and only one round of stumped buddings. Thus the replanting of surrounding holdings can be further phased out depending on this supply of planting materials. After the third year, shading becomes a problem. However, it is also possible to establish another nursery on a newly planted holding.

A smallholding of 2 ha will provide the equivalent of 1.48 ha of nursery space if the planting distance is 9.1 m by 2.4 metres. If only budded stump is raised, an annual production of 91 250 stumps for three years can be expected. This will be sufficient to supply planting materials to 186 ha annually at 494 stumps per hectare, inclusive of supply. Similarly, the ratio of the area of smallholding nursery to the area of the surrounding smallholdings due for replanting can be worked out for each of the other advanced planting materials.

For example, in the case of stumped budding, only one harvest is possible in the three year period. The 2 ha nursery holding yielding 1.48 ha for nursery purposes will yield a total of 10 950 stumps. This is sufficient to supply planting material to only 22.2 ha of field planting. Thus, if this is the planting material chosen for field establishment, the nursery land requirement will have to be worked out accordingly.

Table 29 provides the ratio of this nursery land area to the area of field planting that it can cater for, using different planting materials. A uniform 2 ha holding planted at 9.1 m by 2.4 m will form the basis for comparison.

TABLE 29
RATIO OF NURSERY LAND TO FIELD AREA CATERED FOR

	Area of holding (m)	*Available land for nursery (ha)*	*Total production for 3 years*	*Field area catered for (ha)*
Budded stump	2	1.48	91 250 x 3	554
Mini stump	2	1.48	43.800 x 2	177
Large polybag plant	2	1.48	25 174 x 2	102
Stumped budding	2	1.48	10 950	22

Various types of planting materials can be produced on the same nursery holding based on the ratio given in *Table 29*. The ratio will change if a different planting distance is adopted in the nursery holding. *Table 28* will provide the proportional change.

Thus to summarise, it is recommended that more Government sponsored nurseries be set up, preferably at the district level. This will provide many advantages and reduce much of the difficulties encountered in the production and handling of planting materials.

To promote greater efficiency of land use, smallholder's replant can be used as a temporary nursery for raising planting materials during the early years of the main crop. This further facilitates the better distribution of planting materials. In such projects, the full support of the extension staff is vital.

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APPENDIX I

Table for Metric Conversion to Imperial Units

1 ml	=	0.002 oz
1 litre	=	1.761 pints
	=	0.220 gallon
1 litre/ha	=	0.713 pint/acre
1 kg/ha	=	0.892 lb/acre
	=	0.008 cwt/acre
1 centimetre	=	0.394 inches
1 metre	=	1.094 yards
1 gram	=	0.035 ounces
1 kilogram	=	2.205 pounds
1 sq metre	=	10.764 sq feet
	=	1.196 sq yards
1 hectare	=	2.471 acres
1000 points per hectare	=	405 points per acre
1 km per hour	=	0.621 miles per hour
1°C	=	5(F - 32)/9