The Government of Malaysia
The State of Pahang

PAHANG TENGGARA

Regional Masterplanning Study

Forestry Development

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PAHANG TENGGARA REGIONAL MASTERPLANNING STUDY

Forestry Development In Pahang Tenggara

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1.0 INTRODUCTION

This supporting report to "The Masterplan for the Development of Pahang Tenggara" is divided into two parts. Part I deals with the treatment of the broad issues of Forestry as they relate to the Masterplan. Part II consists of a series of Appendices which detail specific aspects of the work which either substantiate areas of the analysis or provide additional information. In addition to the appendices A—I bound into this volume there are appendices I and II bound separately. Appendix I entitled "Forest Inventory Data for the Pahang Tenggara Region" contains stand and stock tables plus the 12 coloured maps of the Forest types of the study area. Appendix II entitled "The Lesong Forestry Complex Feasibility Study" consists of the report on that project as detailed for loan agency purposes. This volume therefore does not contain all of the detail of that particular industry but does describe the principle characteristics of the project proposal.

1.1 TERMS OF REFERENCE

Article III of the Agreement "Description of the Project" states that the project shall consist of Regional Planning and other services with the following specific reference to Forestry.

"(*b*) Investigation of possible land use including agriculture, grazing, townsites, recreation, wildlife management and forest, both natural and man made.

Article IV—"Obligations of FENCO" describes the analysis of data available on natural resources inherent in the region and their development potential and where necessary the survey and collection of additional data to:

(*b*) Prepare an overall exploitation programme which provides for the processing of the exploitable timber species and effective management for the permanent productive or protective forest estate.

The Scope of work further elaborates as follows:

(2) *Forestry*—

The study will determine the development potential of the region based on the forest resources and will involve the following:

(*a*) Carry out a survey of the forest resources so as to provide adequate data on the utilisable volume of the standing crop according to present utilisation standards and those predicted for 1975. Guide lines for the decennial revision of the utilisation standards will be provided. The data should be in sufficient detail to plan for the development of forest industries according to a phased exploitation of the timber resources as well as for the management of that part of the forest for which management can be justified on economic grounds. The forest survey, details of which will be discussed between the consultants and the Royal Forest Department, will be based on analysis of the most recent aerial photographs (dated 1966) providing the basic stratification for ground sampling. In the first instance sampling will not be done in existing licensed areas or in areas which are unlikely to be developed in the Second Malaysia Plan, but such areas will be covered on a reconnaissance basis as needed for other purposes. The sampling should provide the following information:

(i) Utilisable standing crop by stem numbers and volume according to species or species groups.

(ii) A forest productivity map in the form of compilation sheets on a scale of 1: 25,000 showing the distribution of (*a*) above according to a predetermined classification which shall be developed following close consultations between the consultants and the Forest Department.

Separate surveys as outlined above will be carried out for three main categories of forests as follows:

(i) Productive hill and lowland forests.

(ii) Productive fresh-water forests, the limit of productive forests to be determined from aerial photo-interpretation and ground sampling.

(iii) Selectively logged forests according to maps showing the location of these forests to be provided by the Forest Department.

(*b*) Recommend the location of forests suitable for development as permanent productive and/or protective forest estates.

(c) Recommend the location of primary forest communities suitable and desirable to be preserved for study, research and other scientific purposes with particular attention to the preservation of a genetic pool for tree breeding and extension purposes.

(d) Advise on management of the forests, including presently unproductive forests, with a view to increasing their productivity as applicable, with due emphasis to the permanent forest estate.

(e) Submit proposals for new forest industries to be established to harvest and process the yield of timber from the existing forest resources, including their impact upon the existing industries locally and on a national scale. Estimate capital requirements and indicate where and how the necessary capital can be secured. Determine the need for managerial, marketing and research assistance and present a proposed solution. The Consultant will also determine the need for advisory services to assist the existing industries to remain competitive.

(f) Co-operate with the UNDP "Pilot Plantations for Quick Growing Industrial Tree Species Project" to ascertain feasibility by introducing industrial plantations to Pahang Tenggara.

(g) Advise on the infrastructure requirements necessary to develop the forest resources and the optimum development of the forest industries, including the provision of financial and institutional incentives and policy changes where appropriate.

(h) Co-operate with the UNDP Project Manager of the "Forest Industry Development Project" to avoid the duplication of effort."

1.2 SOCIO-ECONOMIC CONSIDERATIONS

The analysis relating to the development of forest resources has been conducted within the framework of the exploitation potential of all natural resources in Pahang Tenggara. In this regard reference is made to the alternative strategies Section 4.2 of "The Masterplan of the Development for Pahang Tenggara".

The analysis was thus concerned with the socio-economic effects of forestry development as well as the purely technical. Thus the ability of "forestry" to contribute to the various government objectives of income, employment and social transition were examined on the same basis as the contributions arising from agriculture, or tourist developments. During this exercise, existing restraints within the forest industry were ignored, to obtain an unbiased, although theoretical comparison of the "claim" of forestry development, in its various forms, to the scarce land resources of Pahang Tenggara.

It is readily apparent that the chief rivals for reasonably flat land (less than 20) are forestry and agriculture. The comparable investment returns were assessed by cost benefit analysis which considered all of the major variables from market prices to cost of individual labour and equipment items over time. On the basis of virgin forest exploitation and sophisticated product manufacturing, forest proved to be a potentially superior investment on most classes. However, this result was based on an integrated system of exploitation which tied the resource to the manufacturing facilities in a manner which is not generally practised in West Malaysia. To phase in this new technique would take time. By comparison the agricultural industry was already "integrated". Sophisticated techniques were already common practice. However, in agriculture—yields were more sensitive to soil quality.

From an employment point of view agricultural development provided more and cheaper jobs. Yet incomes were superior in forestry and the greater range of skills required was much more conducive to providing opportunities for advancement at the worker level.

The question of the "roles" to be played in the development of Pahang Tenggara by "forestry" and "agriculture" therefore became a matter of trading off the employment and investment benefits of proven agricultural crops on good soils against the income, skill producing, and investment benefits of forestry with "improved" techniques on less good soils. In both cases "research" was sufficiently critical to necessitate a re-evaluation of the relative positions of forestry and agriculture by 1980. Agricultural diversification prospects would be known by then and forestry techniques would be proven, furthermore the relative priority of employment in the Second Malaysia Plan may be superseded by income and skill producing objectives by the Fourth Malaysia Plan.

In the following sections consideration is given to the various means of establishing within Pahang Tenggara a forest industry which is more efficient than the traditional West Malaysia practice. Improvements which are possible now are divided into management aspects which are dealt with in this section and utilization aspects which are examined in Section 4.0. The research and development necessary for further improvements in both categories are discussed in Section 5.0 although it should be noted that many facets are National rather than Regional in implication. Pahang Tenggara is not isolated from established practice, indeed the industry outside the region must continue to draw resources from the study area as they have done in the past (as has been seen from the previous section). In this regard it is useful to specify some of the major objectives which apply to the management of the forest resource, whether in Pahang Tenggara or elsewhere.

1.3 FORESTRY OBJECTIVES

At present, West Malaysia enjoys a good market for several of its Dipterocarp species. These relatively high priced species are presently supporting a disorganized, inefficient industry. This situation cannot be expected to continue indefinitely, due to competition from other countries such as Indonesia. It is therefore the responsibility of all concerned to reduce costs and improve efficiency. One of the best ways to do this is to introduce policies and regulations which encourage industry to modernize and to increase its efficiency as will be discussed in later sections. Positive objectives which, although recognised, are not being pursued in an active and systematic manner are summarised hereunder:

(*a*) Assure established industry of a reasonable volume of round wood for a specified period of time through the introduction of a quota system.

(*b*) Through intensive geographical and sequential planning of its extraction, lay out the shortest possible road system to ensure that the industry can reduce its log hauling costs to the absolute minimum.

(*c*) Adjust royalty rates to reflect a fixed percentage of the market value of the various species extracted.

(*d*) Revise scaling methods and royalty collection procedures to reduce operational time losses and paper work.

(*e*) Assign quotas only to mills that can demonstrate that they will increase their efficiency and improve their utilization of species and sizes.

It will be noted that many of these recommendations refer to transportation efficiencies. It is well to remember that, except for felling and bucking, logging is simply an exercise in various forms of transportation.

2.0 FOREST RESOURCE

2.1 INTRODUCTION

The forests of Pahang Tenggara are classed as rain-equatorial and are composed of many species forming one or two storeys. More than 200 different species or species groups have been identified in the region. A high proportion of these trees belong to the Dipterocarp family. The Forest was found to differ in both species composition and volume from area to area within the region. The differences reflect a correlation with physiographic features of the terrain and with the pattern and quality of drainage. Poor drainage conditions constitute the major element adversely affecting the forest stand, while the type of soil has only a secondary influence.

2.1.1 Forest Types

The correlation of the forest types with the physiographic features can be illustrated briefly as follows:

The peaks, few higher ridges, and plateaus exhibit stunted growth of indifferent species occurring throughout the area, with some scattered undersized Dacrydium spp. (Coniferae). Dipterocarps are absent. This type, termed "Edaphic" is non-productive and is scheduled as protective forest cover.

Descending from the peaks is a productive Hill Dipterocarp Forest, usually with Seraya (Shorea curtisii), an endemic characteristic species of the Dipterocarp family. The type has an overall volume surpassing 3,000 cubic feet per acre.

Below the hills the undulating terrain is covered by a stand of Lowland Dipterocarp Forest, characterised by Red Meranti, Keruing and Balau. The type has an overall volume around 2,500 cubic feet per acre.

The undulating terrain merges into flat Lowland Dipterocarp Forest with Red Meranti, Keruing, Kempas (Leguminosae) but without Balau. The type has an overall volume between 2,000 and 2,500 cubic feet per acre.

Descending further are Riverine Forest, Marginal Flat Forest and Seasonal Swamp Forest, all of poor drainage of a similar species composition to the Lowland Dipterocarp Forest but with higher occurrence of non-Dipterocarp species and volumes below 2,000 cubic feet per acre.

Peat swamps are of different character and vary from potentially productive on somewhat higher ground to non-productive near water courses and non-forest in the permanently flooded areas. The potentially productive Peat Swamp Forest is characterised by fewer species, approximately 40 of which 15 are of any consequence with dominating Kempas, Ramin and Durian with Meranti Paya as only Dipterocarp. The overall volume is over 2,000 cubic feet per acre.

A Casuarina-Jambu-Terminalia forest on coastal sand and Mangrove forests in tidal river estuaries are insignificant in area and will be protected as parklands or reserves.

The volumes quoted above are in true cubic feet inside bark, and refer to trees of 12 inch diameter at breast height and larger, of all species within the forest type.

2.2 INVENTORY METHODOLOGY

2.2.1 General

Stratified intentional sampling by variable plot was used to enable the team to survey the extensive area within the limited time and budget.

2.2.2 Blocks

To accommodate the priorities indicated by the Government and to make the best use of the limited access, the study area was divided into blocks. The blocks coincide to a great extent with natural divisions based on configuration of the terrain and on drainage pattern. There are therefore, differences in the composition and volume of the forest stand within the corresponding types of different blocks.

2.2.3 Stratification and Allocation of Plots

The forest within the blocks was stratified using the aerial photographs, so that there would be more variations between the different types than within them. Optimum allocation of sampling plots was based on this stratification. The number of plots and sampling accuracy were controlled by statistical analyses.

2.2.4 Flow Chart and Specifications

The flow chart presented here summarises the survey method. Section 6.0 Appendix A of this

report gives specifications and procedure instructions in detail, as applied in the collecting and processing of field data.

2.3 FIELD WORK SUMMARY

Trees have been tallied by species and by diameter classes on 8,200 sample plots for the compilation of Stand Tables. Two thousand eight hundred trees have been felled, measured and analysed for Volume and Defect Study.

2.3.1 Distribution of Sampling Plots

The sampling plots were distributed as follows:

Virgin Forest:	
Hill Forest	2,100 plots
Undulating Forest	2,400 plots
Flat Forest	1,500 plots
Marginal and Swamps ...	700 plots
Logged Forest	1,500 plots
Total ...	8,200 plots

2.3.2 Sampling Accuracy

To control the intensity of the sampling, field data were analysed and computations of coefficient of variation and sampling error were carried out for every forest type.

The coefficient of variation based on the number of trees tallied averages 44.8 percent in the virgin forest and 62.8 percent in the logged forest. An average of 5 trees were tallied per sample in Virgin forest and 4 trees in logged forest.

The sampling error at a probability of 95 out of 100 is for the total Inventory Survey $\pm 1.12\%$, for the total Virgin forest $\pm 1.14\%$, for logged forest $\pm 3.36\%$, for potentially productive peat swamp $\pm 3.82\%$, and for non-productive forest, including swamps, marginal and edaphic types is $\pm 5.90\%$. The achieved sampling error indicates high sampling accuracy.

2.4 RESULTS OF SURVEY

The results of the survey are presented in Forest Cover Maps and in Stand and Stock Tables in Appendix I to this report. Forest cover mapping was carried out on the topographic maps at a scale 1: 25,000, and final maps were reduced to the scale of one inch to one mile, with a grid corresponding to that of the Government topographic series.

The various forest types are differentiated on the maps by outline, colour and symbol; in addition each type is marked by a circle which contains a consecutive number of the type, a Stock Table code and the acreage.

The Stand and Stock tables (number of trees and volume, respectively) present the pertinent figures per 100 acres, by species and diameter classes.

Volume values for any area can be worked out by application of appropriate stock table to the acreage shown on the type on the map. The areas of forest types were measured on the forest cover maps by polar planimeter. Areas were summarized and reconciled by maps. The area summaries are filed with the survey worksheets.

The forest cover maps and the stand and stock tables, presented as appendices to this report, are under separate cover.

2.4.1

Table 2.4a—Area Summary (acres)

Forest Type:		
Productive—Virgin		
Hill Dipterocarp Forest		
Seraya Ridge	74,000	
Seraya Slope	74,000	
Seraya Dissected	95,000	
Non Seraya	118,000	
Sub-Total Hill Dipterocarp Forest		361,000
Lowland Dipterocarp Forest		
Balau—Undulating	351,000	
Kapur—Undulating	2,000	
Meranti—Flat	162,000	
Keladan—Riverine	16,000	
Sub-Total Lowland Dipterocarp Forest		531,000
Sub-Total Virgin Productive Forest		892,000
Productive—Logged		461,000
Peat Swamp Potentially Productive		272,000
Sub-Total Productive Forest ...		1,625,000
Non-Productive		
Edaphic Hill	36,000	
Marginal Flat	49,000	
Seasonal Swamp	115,000	
Permanent Swamp	270,000	
Sub-Total Non-Productive ...		470,000
Non-Forest (including clearings, Plantations, Water)		390,000
GRAND TOTAL ...		2,485,000

2.4.2

Table 2.4b—Volume Summary

Volume in 1,000 cubic feet by diameter classes

Forest Type	*12"-20"*	*24"-36"*	*40"-68"*	*Total*
Seraya Ridge	135,768	94,650	28,188	258,606
Seraya Slope	137,014	82,064	20,876	239,954
Seraya Dissected	143,889	96,191	24,909	264,989
Non Seraya	151,657	109,148	26,425	287,230
Sub-Total Hill	568,328	382,053	100,398	1,050,779
%	54.1	36.4	9.5	100.0
Balau—Undulating	444,333	385,595	117,478	947,406
Kapur—Undulating	2,903	2,754	560	6,217
Meranti—Flat	199,124	160,877	34,305	394,306
Keladan—Riverine	24,146	10,580	1,259	35,985
Sub-Total Lowland	670,506	559,806	153,602	1,383,914
%	48.4	40.5	11.1	100.0
Logged Forest	529,136	216,859	42,583	788,578
%	67.1	27.5	5.4	100.0
Peat Swamp Potential	213,606	176,104	17,936	407,646
%	52.4	43.2	4.4	100.0
GRAND TOTAL	1,981,576	1,334,822	314,519	3,630,917
%	54.6	36.8	8.6	100.0

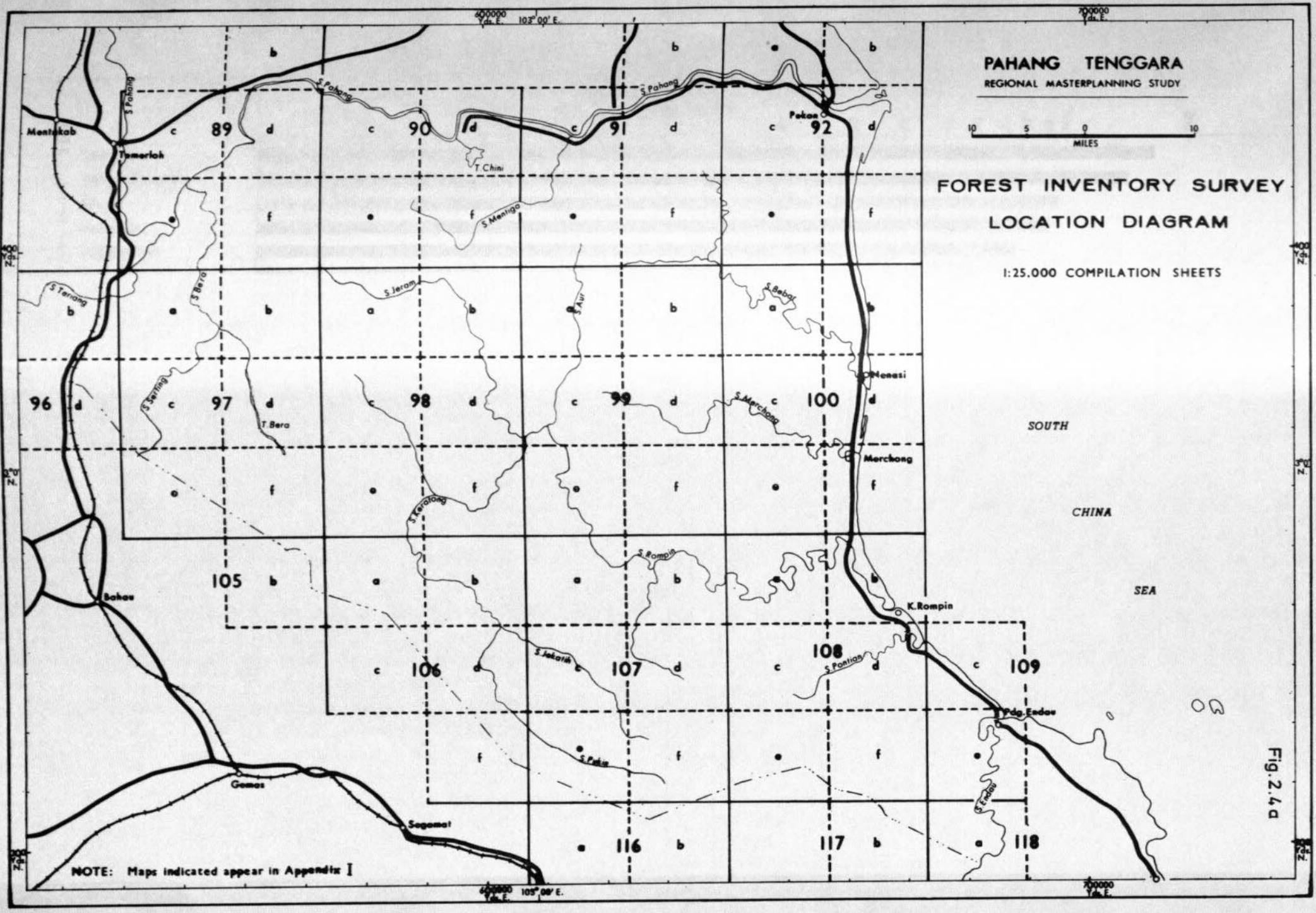
NOTE: The figures are rounded to the nearest thousand cubic feet; 25% of the volume was deducted for pathological and decadent defect in Peat Swamp forest and 10% in all other forest types.

2.4.3 Volume Definition

The "Volume" shown includes trees of all species of diameter at breast height 12 inch and larger. These volumes are based on local volume tables and refer to merchantable bole defined as that part of bole between stump height and 10 inch diameter outside bark, or branches, whichever is reached first. Volume tables are compiled by Smalian's formula, in true cubic feet, inside bark. The volume Tables, indicating defect for each species were issued as the Study Report No. 8.

2.4.4 Species Composition

The following graphs, Figures 2.4a, b, c and d show species composition of the Hill and Lowland Dipterocarp forest. In the first two graphs the species of the two forest strata are arranged in the order of volume to demonstrate the potential of the resource. In the two subsequent graphs the same species are regrouped by wood colour and weight, air dry. It is suggested that species of similar colour and weight can be interchangeable in application for many uses. A brief description of the species shown in the graphs, arranged in alphabetical order for convenience e.g. Balau, Shorea spp., Dipterocarpaceae and so on, large trees of good form, abundant, air dry weight 55 lbs/cu. ft., hard, dark brown, used for heavy duty flooring, heavy construction.


PAHANG TENGGARA
REGIONAL MASTERPLANNING STUDY
10 5 0 10
MILES
FOREST INVENTORY SURVEY
LOCATION DIAGRAM
1:25.000 COMPILATION SHEETS
SOUTH
CHINA
SEA
Mentekab
Temerloh
Pekan
Menasi
Merchong
Bahau
K.Rompin
Pdg.Endau
Gemas
Segamat
S.Pahang
T.Chini
S.Mentiga
S.Jeram
S.Aur
S.Bebar
S.Ternang
S.Bera
S.Serting
T.Bera
S.Merchong
S.Kerotong
S.Rompin
S.Jekatik
S.Pontian
S.Pelus
S.Endau
89
90
91
92
96
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98
99
100
105
106
107
108
109
116
117
118
NOTE: Maps indicated appear in Appendix I

Fig. 2.4a

SPECIES COMPOSITION
HILL FOREST

VOLUME IN MILLION CUBIC FEET

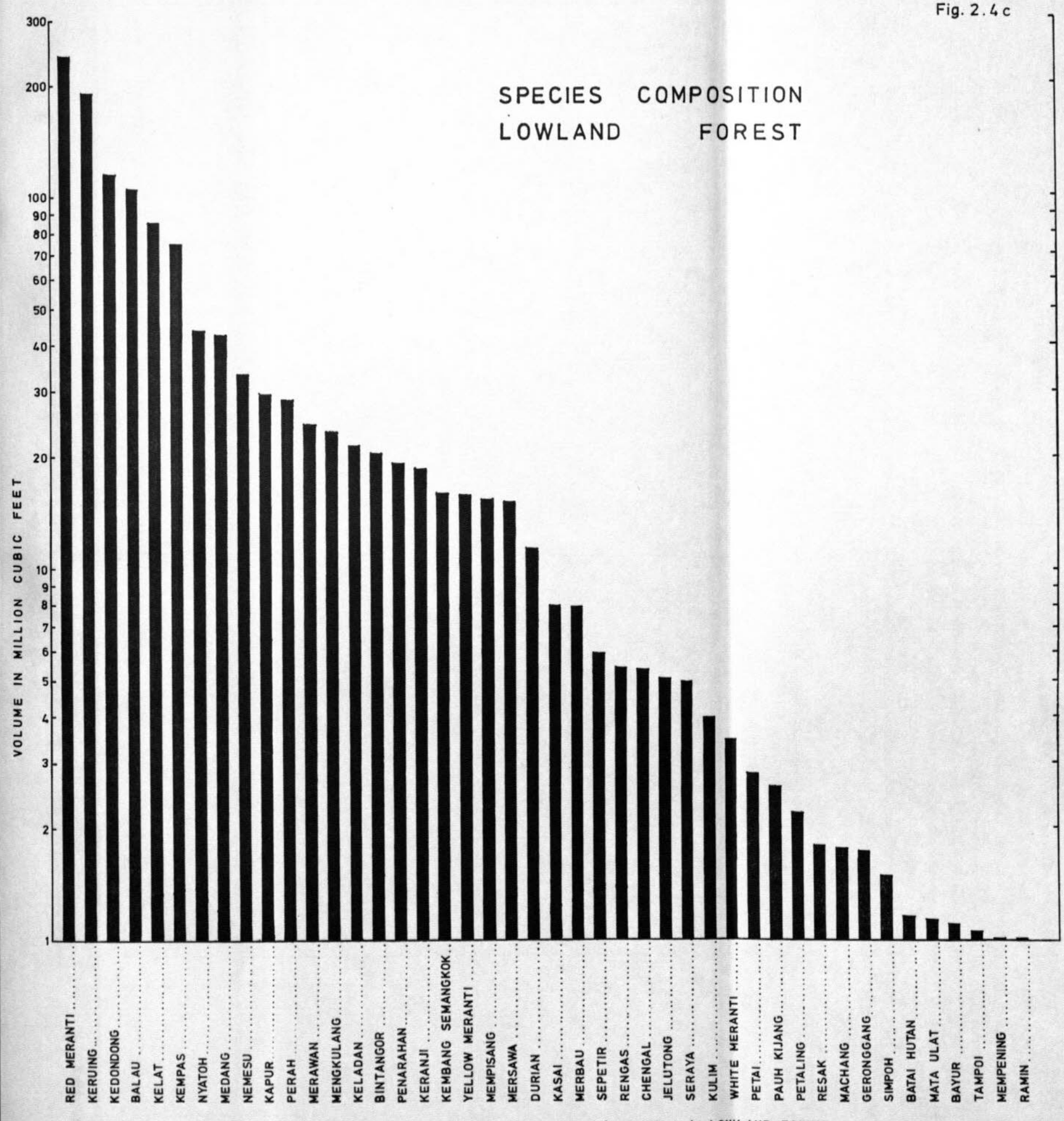
1 2 3 4 5 6 7 8 9 10 20 30 40 50 60 70 80 90 100 200

SERAYA
RED MERANTI
KELAT
KERUING
KEDONDONG
KAPUR
PERAH
KEMPAS
NYATOH
RENGAS
BALAU
BINTANGOR
MEDANG
NEMESU
MERAWAN
KERANJI
PENARAHAN
MENGKULANG
KEMBANG SEMANGKOK
YELLOW MERANTI
CHENGAL
RESAK
PETALING
MACHANG
MERSAWA
KASAI
MATA ULAT
MEMPISANG
DURIAN
MERBAU
MERBATU
SEPETIR
MELUNAK
WHITE MERANTI
MINYAK BEROK
TULANG DAING
GIAM
KELADAN
KULIM
KANDIS
TEMPONEK
PELONG
JELUTONG
SIMPOH
BATAI HUTAN
MEMPENING

NOTE: Listed are species contributing 1% or more of total volume per acre in any type in HILL FOREST.

Fig. 2.4b

Fig. 2.4c



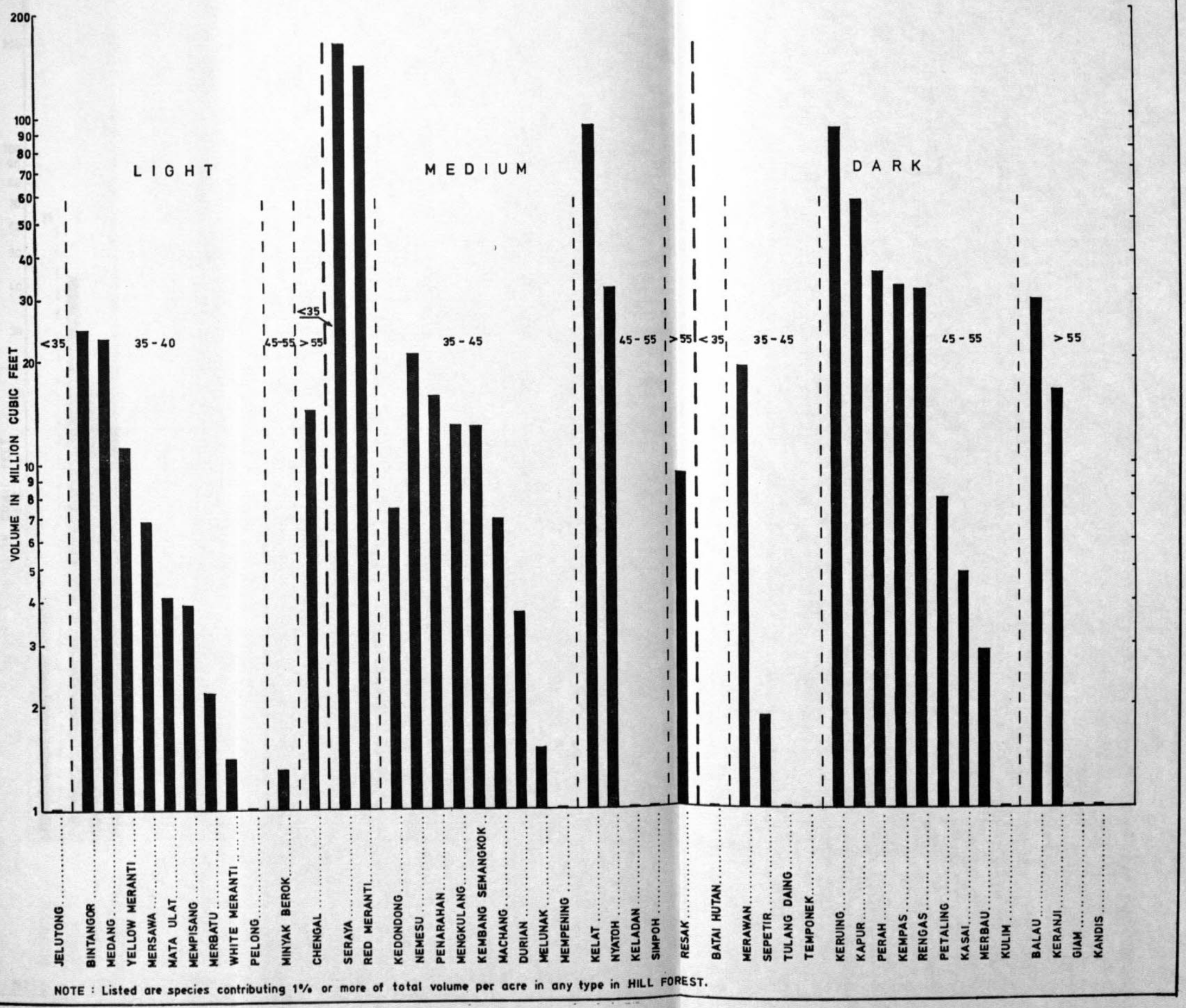
NOTE: Listed are species contributing 1% or more of total volume per acre in any type in LOWLAND FOREST.

TIMBER CHARACTERISTICS OF SPECIES IN HILL FOREST

Fig. 2.4d

COLOUR - Light, Medium, Dark.

AIR DRY WEIGHT (lb./cu.ft.) - <35, 35-45-55, >55.



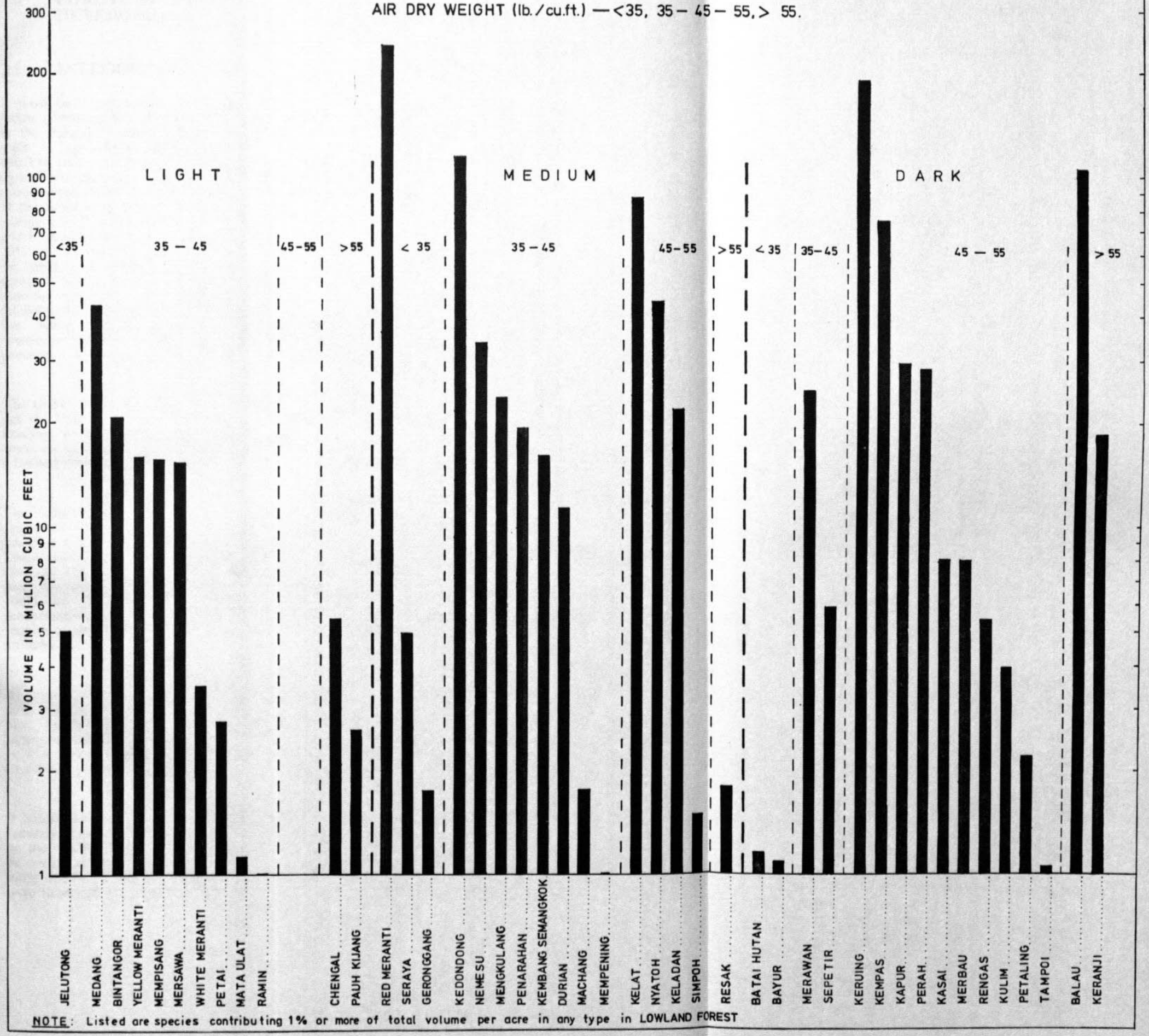
NOTE : Listed are species contributing 1% or more of total volume per acre in any type in HILL FOREST.

TIMBER CHARACTERISTICS of SPECIES in LOWLAND FOREST

Fig. 2.4e

COLOUR — Light, Medium, Dark.

AIR DRY WEIGHT (lb./cu.ft.) — <35, 35 – 45 – 55, > 55.



NOTE: Listed are species contributing 1% or more of total volume per acre in any type in LOWLAND FOREST

3.0 FOREST RESOURCE DEVELOPMENT

3.1 INTRODUCTION

It must be recognised that the most significant factor governing the development of the forests in the Pahang Tenggara Region is the present scale of agricultural development until 1980. 660,000 acres are scheduled to be cleared for agricultural purposes with the result that forest management cannot be practised on a great part of the forest area. This period until 1980 will be mainly one of liquidation of the forest resource and if current standards are continued, only 20 to 30% of net volumes will be utilized. However, the orderly liquidation of the forest can be planned within the limits of the agricultural clearing scheduled and existing transportation facilities. The importance of better utilization of the wood volumes contained within the remaining forests is a much more difficult problem.

The timber supply in Malaysia is not unlimited, but the high priority attached to the agricultural clearing operations place such large volumes of wood on the market, that the actual situation of a limited remaining forest resource is obscured.

The improvement in species and tree size utilization requires industrial plants capable of handling a wide range of species and tree sizes. Unfortunately plants with these capabilities do not exist within or adjacent to the Pahang Tenggara Region. The necessary utilization facilities could be provided by the upgrading and modernization of existing plants but this would require a complete change in plant management attitudes.

At present, within the forest industries there is little relation between the forest resource and plant design. Few plants have an assured timber supply. Current practice is to purchase log supply on the open market from logging operators at negotiated prices.

It becomes a question of how much will existing industry progress when there is an excess of logs on the market. If an assured timber supply must be made conditional on the operation of an integrated forest complex, existing concerns would have to accept not only additional responsibilities regarding forest development, but also the commitment to make major capital expenditures to improve wood utilization capabilities. Unfortunately it is questionable whether many existing companies would choose this course of action until the shortage of wood supply became apparent. With the current emphasis on agricultural clearing, there is little need, from the plant owner's point of view, to operate in a different manner than the present one.

3.2 EXISTING RESOURCE DEVELOPMENT

3.2.1 Present Practices

The government policy towards the forest resource has been one of protection rather than of sustained yield management. In the Pahang Tenggara area several forest reserves were established where the issuing of cutting licences was restricted. There have been only a few blocks on which the Malay Uniform System was subjected to any experimentation.

Although some long term timber cutting licences have been issued, it is only recently that these have been made available to conversion plants as a means of obtaining an assured timber supply. The majority of timber cutting licences were held by logging contractors who sell the logs to the various conversion plants. There is little encouragement, therefore, to use the less commercially accepted species and in spite of an obligatory species cut list there is still a very substantial volume of wood being left on the logged over areas.

Royalties are set at fixed rates for individual species, and do not always reflect the relative value of the woods. Premiums, which are a land rental tax, vary with the licence area and usually reflect in part the value of the licence from a development cost aspect. The combination of both royalty and premium, however, does little to encourage more complete species utilization. In some cases, when royalties are high in relation to the value of the logs, this combination actually discourages complete species utilization.

3.2.2 Present Development

The combination of clearing the forest lands for conversion to agricultural purposes and a forest policy which is not on a sustained yield basis has resulted in a serious depletion of the forest

resources within Pahang Tenggara. In 1970 alone over 1,000,000 Forest tons were extracted from the region.

The effect of present practices has been the development of utilization plants which are usually small, unsophisticated, and capable of producing a limited number of products. Utilization standards are low, and most mills will process only high quality logs of only a limited number of tree species. Some small plants are located within Pahang Tenggara, but most are located on the periphery and are only partly dependent on their wood supply from the study area.

The existing conversion plants have only a limited capacity to utilize logs from Pahang Tenggara and a large percentage of the logs are exported as round wood to Singapore and other offshore countries, mainly Japan. Only a limited number of species and sizes are saleable and the cost of transporting logs such long distances has contributed to the restricted utilization of only the high value species.

3.3 FOREST RESOURCES CATEGORIES

In designing the optimum pattern of resource exploitation for the Pahang Tenggara Region it is necessary to relate the various types or categories of forest development to the overall masterplan. The detail of the masterplan is documented in "The Masterplan for the Development of Pahang Tenggara". Generally speaking the masterplan, through comprehensive interdiscipline analysis has resolved the landuse pattern of Pahang Tenggara which therefore has determined the extent to which permanent forest development is possible, where forests should remain for conservation or protective measures and where forestry operations should "serve" the agricultural programme through logging in areas to be cleared.

For the detailed forestry programme to be defined it is necessary to consider these three aspects of development in greater detail. In areas where the analysis has indicated that forestry operations could be efficiently carried out indefinitely, it is proposed to evolve an intensive management system which can maximise the sustained yield of timber in the areas in question. When the produce of an area is committed to a single company a Tree Farm Licence (T.F.L.) is proposed. Where the sustained yield is assigned on a long term basis to more than one conversion plant as an assured timber supply quota the area will be regarded as a Forest Management Unit (FMU).

In areas where the masterplan analysis has indicated conservation or park areas, forest exploitation is prohibited but the management of the areas will place first priority on maintenance of the aesthetic values and protection of the environment. Addition environmental forests will occur throughout the study region as residual areas following agricultural development of forest in scattered blocks often with value as protective forests. These areas are generally too small to be developed on a sustained yield basis as individual blocks, but together have considerable sustained capacity. The areas will be managed as permanent forests with environmental considerations being given priority.

On land scheduled for agricultural development the forests will be liquidated. The liquidation will be mainly on a short term basis before 1980, and longer term afterwards to permit better utilization of the forest being cleared.

3.3.1 Tree Farm Licences and Forest Management Units

Without almost complete species utilization, proper forest management will be difficult if not impossible. To justify expenditures on plants and machinery capable of utilizing and producing saleable products from the majority of the tree species contained within the forest stand an assured timber supply is an essential pre-condition.

An intensive forest management system based on selective cutting of 20 percent of all species, every five years in the same area in perpetuity is proposed for permanent forest within the Pahang Tenggara area. The system will be initiated in the Lesong T.F.L. area (*see* Fig. 3.3) and will be applied to other permanently managed forest areas when operating procedures have been proven and standarized.

The trees selected to be cut will be marked. The marking will be governed by the maturity of the trees and by spacing (canopy manipulation), rather than by species and size preference. The system is applicable to both hill and lowland forest and would eliminate the danger of overcutting and of running the forest stand by the creaming of the most desirable species. The system will also afford protection to slower growing species and will promote regeneration by canopy manipulation. Since no ecological damage will be done to the forest stand the proposed system will be readily convertible should a more advantageous approach be developed at any stage of the management. The details of the proposed system are enumerated in Section 8.0 Appendix C entitled "Intensive Forest Management System".

resources within Pahang Tenggara. In 1970 alone over 1,000,000 Forest tons were extracted from the region.

The effect of present practices has been the development of utilization plants which are usually small, unsophisticated, and capable of producing a limited number of products. Utilization standards are low, and most mills will process only high quality logs of only a limited number of tree species. Some small plants are located within Pahang Tenggara, but most are located on the periphery and are only partly dependent on their wood supply from the study area.

The existing conversion plants have only a limited capacity to utilize logs from Pahang Tenggara and a large percentage of the logs are exported as round wood to Singapore and other offshore countries, mainly Japan. Only a limited number of species and sizes are saleable and the cost of transporting logs such long distances has contributed to the restricted utilization of only the high value species.

3.3 FOREST RESOURCES CATEGORIES

In designing the optimum pattern of resource exploitation for the Pahang Tenggara Region it is necessary to relate the various types or categories of forest development to the overall masterplan. The detail of the masterplan is documented in "The Masterplan for the Development of Pahang Tenggara". Generally speaking the masterplan, through comprehensive interdiscipline analysis has resolved the landuse pattern of Pahang Tenggara which therefore has determined the extent to which permanent forest development is possible, where forests should remain for conservation or protective measures and where forestry operations should "serve" the agricultural programme through logging in areas to be cleared.

For the detailed forestry programme to be defined it is necessary to consider these three aspects of development in greater detail. In areas where the analysis has indicated that forestry operations could be efficiently carried out indefinitely, it is proposed to evolve an intensive management system which can maximise the sustained yield of timber in the areas in question. When the produce of an area is committed to a single company a Tree Farm Licence (T.F.L.) is proposed. Where the sustained yield is assigned on a long term basis to more than one conversion plant as an assured timber supply quota the area will be regarded as a Forest Management Unit (FMU).

In areas where the masterplan analysis has indicated conservation or park areas, forest exploitation is prohibited but the management of the areas will place first priority on maintenance of the aesthetic values and protection of the environment. Addition environmental forests will occur throughout the study region as residual areas following agricultural development of forest in scattered blocks often with value as protective forests. These areas are generally too small to be developed on a sustained yield basis as individual blocks, but together have considerable sustained capacity. The areas will be managed as permanent forests with environmental considerations being given priority.

On land scheduled for agricultural development the forests will be liquidated. The liquidation will be mainly on a short term basis before 1980, and longer term afterwards to permit better utilization of the forest being cleared.

3.3.1 Tree Farm Licences and Forest Management Units

Without almost complete species utilization, proper forest management will be difficult if not impossible. To justify expenditures on plants and machinery capable of utilizing and producing saleable products from the majority of the tree species contained within the forest stand an assured timber supply is an essential pre-condition.

An intensive forest management system based on selective cutting of 20 percent of all species, every five years in the same area in perpetuity is proposed for permanent forest within the Pahang Tenggara area. The system will be initiated in the Lesong T.F.L. area (*see* Fig. 3.3) and will be applied to other permanently managed forest areas when operating procedures have been proven and standarized.

The trees selected to be cut will be marked. The marking will be governed by the maturity of the trees and by spacing (canopy manipulation), rather than by species and size preference. The system is applicable to both hill and lowland forest and would eliminate the danger of overcutting and of running the forest stand by the creaming of the most desirable species. The system will also afford protection to slower growing species and will promote regeneration by canopy manipulation. Since no ecological damage will be done to the forest stand the proposed system will be readily convertible should a more advantageous approach be developed at any stage of the management. The details of the proposed system are enumerated in Section 8.0 Appendix C entitled "Intensive Forest Management System".

Fig. 3.1

PAHANG TENGGARA
REGIONAL MASTERPLANNING STUDY

FOREST COMPLEX RESOURCES

●-----MILL SITES

10 5 0 MILES 10 20

600000 Yds. E. 103° 00' E.

400 Yds. N.

3° 00' N.

300 Yds. N.

Mentekab
Temerloh
Teriang
Bahau
Segamat
Kg. Melayu
Kg. Aur
Bt. Ibam
Pekan
Nenasi
Merchong
K. Rompin
Pdg. Endau

S. PAHANG
S. Teriang
S. Serting
S. Bera
Tasek Bera
S. Mentiga
S. Jeram
S. Aur
S. Bebar
S. Merchong
S. Rompin
S. Keratong
S. Pukin
S. Endau
S. Pontian

MENTIGA FOREST CONCESSION
BUKIT IBAM TREE FARM LICENCE AREA
LADANG PEGAWAI
LESONG TREE FARM LICENCE AREA
PEAT SWAMP FOREST RESOURCE I
F.M.U. 1 BEBAR
PEAT SWAMP FOREST RESOURCE II

SOUTH CHINA SEA

3.3.1.1 Tree Farm Licence Agreement

One of the methods of providing an assured timber supply is a Tree Farm Licence agreement. The agreement outlines and describes the area given to the licensee, stipulates the condition and requirements which must be met by the licensee, including the type of industry to be established forest management methods, regulation of annual cut, and financial obligations.

In return the Licensee receives from the Government exclusive rights to the timber conditional upon compliance with the Agreement requirements. A sample of the Tree Farm Licence Agreement is included in Appendix D of this volume.

3.3.1.2 FMU—Long Term Timber Sales Contract

The FMU is similar to the TFL except that the management and planning on sustained yield basis is a function of the Pahang Tenggara Development Authority who specify the timber rights that are to be issued by Long Term Timber Sales as quota allocations to selected forest utilization complexes. The Long Term Timber Sale Agreement is to be processed and royalties collected through the normal state forest administrative channels. The long Term Timber Sale Contract should include:

- contract period a minimum of 5 years
- the contract should stipulate that a minimum of 75% of the wood volumes removed from the sale area must be utilized in the licensee's forest complex
- the annual cut, equal to the mill quota, must be stated in the contract
- an annual cutting plan must be a requirement of the contract
- the areas proposed for Long Term Timber Sale contracts will be covered by a full operational timber cruise which must provide accurate volume and species data by diameter classes for the sale area
- the Licensee would be permitted an under or overcut of up to 50% of the annual cut in any one year with the provision that at 5 year intervals and at the end of the contract period, accumulated undercut or overcuts should not exceed 10%
- the operational timber cruise volumes will be used to determine the undercutting and overcutting status of the Long Term Timber Sale
- panalties must be provided for in the contract to cover under and overcutting beyond the stated limits
- only trees marked for cutting shall be removed from the sale area. Penalties shall be assessed for the removal of unmarked trees, and for marked trees not removed from the sale area.
- the costs incurred in marking the trees to be cut in the sale area shall be borne by the Licensee.

It is recommended, that a programme for marking trees to be cut in the areas covered by Long Term Timber Sales should be initiated, at least on a trial basis, and in accordance with experience gained in the management of the Lesong T.F.L. Area.

3.3.2 Cutting Area Restrictions

The large areas of forest required to be cleared between 1972 and 1980 for agricultural purposes will produce too great volumes of timber for any of the existing utilization plant that to date have been at least partly dependent for its raw material requirements upon the Pahang Tenggara Region. Any cutting outside these agricultural clearing areas will further flood the market. These forests should be preserved for the future when species and tree size utilization standards can be improved.

3.3.2.1 Cutting Permit—1972-1980

With the necessity of keeping to the agricultural schedule, Cutting Permits issued during this period need only cover the requirements of an orderly forest liquidation programme. Increased utilization of the species and tree sizes in the forest stands should be encouraged during this period as volumes remaining after logging will be destroyed in the clearing process.

It is proposed, therefore, that the permits issued during this period include the following provisions:

- timber royalties for obligatory species be set at rates equivalent to 10% of the market value of the logs. Rates should be

revised annually in accordance with revision of royalties as proposed in the following section.

— royalty rates for non-obligatory species and for logs 17″ and under butt diameter should be set at M$0.05 per cubic foot.

— any competitive bidding should be restricted to obligatory species and logs 18″ and over butt diameter.

3.3.3 Royalty Rates Revision

The royalty rates, when unrealistically high, contribute to poor species utilization, particularly those species with low market value but high royalty rates. The royalty rates should reflect the relative value of the species and thus contribute to increased utilization through the use of the lower value obligatory species. If rates were based on a percentage of the market value the government would be in a position to increase revenues as the market values increased. Initially, the species should continue to be divided into obligatory and non-obligatory species, with a nominal rate placed on the non-obligatory species to encourage their use.

As a market is developed for the non-obligatory species and new Timber Sale contracts encourage or require more complete utilization of the tree species, all timber royalties should be based on market value, with no obligatory-non-obligatory separation of species. It is suggested that the royalty rates be set at 10% of the market price of the log. It will take time, however, to obtain the necessary data to make the rate determination a systematic and routine calculation. It is recommended that the royalty revision procedures be as follows:

3.3.3.1 Interim Royalty Adjustment

Reliable market values will be difficult to obtain initially without the authority to collect the necessary data. It is suggested that the best information that is currently available be used to make an interim adjustment, and the obligatory species' royalties be set at 10% of the estimated market value. Royalties should be revised at least annually in the initial period.

3.3.3.2 Royalty rate as a Percentage of Market Value

To obtain the necessary market value information all timber cutting permits and licenses should include a clause requiring the submission of all sale and purchase records including species, volume, and selling or purchasing price. Appropriate forms should be supplied to standardize the information received. When sufficient reliable data on market values have been obtained, royalties by species could be set at 10% of the market value. Initially, rates should be revised annually, but quarterly revision should be made eventually. All calculations should be based on the latest 6 months marketing information to even out short term fluctuations. Royalty rates would be first calculated for the obligatory species, but as market values become established royalty rates should be established for the other species.

— Royalty rates should be set at rates current at the date of issue of the contract. Royalty rates should be revised at least annually, with revisions made only when rates have fluctuated a minimum of 15%.

3.4 PERMANENT PRODUCTIVE FORESTS

3.4.1 Lesong Tree Farm License— 116,000 acres

To be able to carry out sustained yield management of the forest area on any realistic basis, the utilization of nearly all the species contained in the forest is required. This is a departure from existing practice and to obtain this level of utilization requires a complex with the capability to develop markets for the products manufactured. Both the intensive management proposed for the forest area, and the construction of the manufacturing complex will require the expenditure of an estimated M$40 million. In order to justify this level of investment an assured supply of raw materials must be provided. It is proposed, therefore, that a company be assigned the sole cutting rights to that part of the Lesong Forest, referred to as the Lesong Tree Farm License (T.F.L.) area, and that the construction and continuous operation of an integrated manufacturing plant, along with the intensive management of the T.F.L. area, be a condition of the Tree Farm License contract.

3.4.1.1 Lesong integrated forest complex

A Forest Complex Feasibility Study has been prepared for the Lesong area. The complex would be based on modern perpetual yield forest management which would support an integrated sawmill and plywood plant as described in detail

in the Appendix II to this report. The study shows that conditions of access, weather, terrain and timber quality, timber ingrowth and distribution are favourable to the establishment of a forest management operation capable of producing 125,000 forest tons per annum in perpetuity. The Lesong T.F.L. area contains an inventoried net merchantable volume of some 160 million cubic feet or over 3 million timber tons. This is sufficient to sustain the proposed operation for 25 years on a once over basis, a period more than adequate for the return of investment. A forest inventory carried out by the Study indicates sufficient ingrowth to permit, under a sustained-yield management system, an annual cut of 6,250,000 cu ft in perpetuity. The world market is growing rapidly for the tropical hardwood products which can be produced in the proposed Lesong Forest Industry Complex. The market prospects are especially favourable in such markets as Western Europe, Japan, the United States and Australia where Malaysian wood products are already well established. The trend in market growth is away from raw logs to semi-finished and fully finished products. This pattern is in line with Malaysia's interest in upgrading exports to obtain higher sales value per ton for raw materials. It is also in line with the planned objectives of the Lesong Complex which will sell 80% of its output in upgraded form.

The forest products complex, by definition, is an integration of wood-based industries designed to provide maximum utilization of a given forest resource consistent with economics, markets and infrastructure. Specific benefits resulting from integration in the forest industry include:

(*a*) Utilization of a larger number of species and thus a larger portion of the forest resources.

(*b*) Sharing of services and processing at various stages.

(*c*) Profitable utilization of residues.

(*d*) Best "end-use" for a given grade and species.

(*e*) Ability to further process a basic product.

(*f*) Opportunity to diversify, at a given stage in processing to a greater variety of end products.

(*g*) Higher "per acre" yield with resultant "per unit" decrease in fixed costs.

(*h*) Common sales and marketing organizations.

The sawmill has been the prime user of forest resources and has paved the way for the forest products complex and the resultant sophisticated management of much of the world's timber supply. The veneer and plywood industry was a natural addition to the sawmill to better utilize the higher grade timber. Preliminary forest inventory data of the Lesong T.F.L. indicate a potential of 50% medium to high grade logs of species suitable for Veneer-Plywood production.

The forestry complex lends itself admirably to the Lesong area and its assured raw material supply will encourage the investment of foreign capital which, in turn, will bring in the required management "know-how" and technical expertise during the early years when such experienced personnel are not available in Malaysia. While the raw material base (volume and species) is the main determinant in the number of basic products produced, the degree of integration is limited only by available markets, management expertise and the ability to compete for these markets.

The proposed Lesong Forestry complex is based on the utilization of 5,000,000 cu ft (100,000 tons @ 50 cu ft per ton) annually of round timber. A summary breakdown of labour requirements in skill classification for each division of the complex, indicates a total employment of 431 personnel.

Sawmill Division Labour Requirements

Unskilled	17 men
Semi-skilled	53 men
Skilled	45 men
Highly Skilled	22 men
Technicians	50 men
Supervisors	7 men
Total ...	194 men

Plywood Division Labour Requirements

Unskilled	33 men
Semi-skilled	60 men
Skilled	47 men
Highly Skilled	16 men
Technicians	28 men
Supervisors	11 men
Total ...	195 men

Administrative Division—Manning Table

Unskilled	4 men
Semi-skilled	11 men
Skilled	11 men
Highly Skilled	4 men
Administrative Management ...	5 men
Production Management	7 men
Total ...	42 men

It is recommended that the Lesong Forestry Project be set up as a Joint Venture enterprise. The Joint Venture would combine a Foreign Investor with proven forest industry management and marketing competence with a Government Entity and Malaysian Private Investors. The main interest of any reasonable and substantial overseas investor in an integrated timber harvesting and manufacturing complex in the Lesong would be to participate in a successful project that would result in a fair return on capital invested and the profitable use of his experience in the industry.

There are many forms of corporate and financial structure that could be used to form the Joint Venture Company and no set and hard rules can be established. The investors both foreign and local, in co-operation with the Government entity mut be responsible for negotiating a basis for establishing and operating a viable commercial enterprise. It is suggested that the shares in the Joint Venture Company would be common shares and would be issued in the following proportions:

(*a*) Foreign Investor	49%
(*b*) Government Entity	40%
(*c*) Malaysian Investors	11%
Total ...	100%

The total investment required to establish the full complex as recommended in this report is estimated at M$40 million. Summarized below are the four main components of this total amount:

	Local Currency	Foreign Currency	Total
Forest Concession	M$ 4,000,000	M$ —	M$ 4,000,000
Timber Extraction	4,243,000	9,071,000	13,314,000
Manufacturing	9,764,000	11,053,000	20,817,000
Working Capital	993,000	876,000	1,869,000
	M$19,000,000	M$21,000,000	M$40,000,000

An important feature of the proposed forestry complex is that it is based on intensive forest management with the objective of sustained yield in perpetuity. The intensive forest management system detailed in Appendix II is designed to improve the existing levels of utilization of the inventoried timber volumes. It is obvious that such improvements cannot take place immediately since only woods of known usage, market acceptance, and hence value, can be readily sold. To sell the unknown wood species, of which there is a considerable volume, will require the development of markets and the introduction of production techniques necessary to produce saleable products. With this in mind, the initial wood volumes for the complex will be obtained from outside the Lesong area from areas which are planned to be cleared for agricultural development south of the T.F.L. In the beginning these areas will be "hi-graded" to more or less current utilization standards in order to produce saleable round wood and easily marketable manufactured products.

Some 11,000 acres scheduled for agricultural clearing and other forest areas located to the sourth of the Lesong T.F.L. area will be allocated to supply the Lesong Forest Complex for the years 1974-1976. The area will be allocated as follows:

Year	Area Agriculture Clearing	Other	Tons Per Acre	Total Volume Tons
1975	2,700 ..	— ..	15 ..	40,000
1976	5,900 ..	— ..	17 ..	100,000
1977	1,400 ..	4,900 ..	20 ..	125,000
TOTAL ..	10,000 ..	4,900 ..	..	265,000

By the end of 1977, standards of utilization by the proposed manufacturing plants will have advanced to the stage where almost total utilization of the tree species within the Lesong forests will be possible. By operating outside the Lesong T.F.L. area during these initial years the productive capacity of the T.F.L. area will be preserved until year 5, when logging operations will commence. As a result, within the Lesong T.F.L. area a high degree of species utilization will be an established logging extractive procedure.

3.4.2 Bukit Ibam Tree Farm License—120,000 acres

This second Tree Farm License area has been established to protect this contiguous resource until such time as the intensive management system to be applied in the Lesong T.F.L. has been proven. A draft proposal[1] was prepared in 1971 for the development of the Bukit Ibam Timber Complex. It is recommended that a similar agreement to that proposed for the Lesong Forest Complex cover the management and development of the proposed Bukit Ibam T.F.L. area. The construction and continuous operation of an integrated forest manufacturing complex must be a condition of the agreement.

As the Bukit Ibam area is adjacent to substantial areas scheduled for agricultural clearing between 1972 and 1982, the initial wood supply should be obtained from these areas. Sustained yield forest management and subsequent development of the proposed Bukit Ibam T.F.L. area should begin in 1980.

The proposed forest manufacturing complex should be constructed and operational a maximum of within 4 years to make possible increased utilization of the wood volumes contained in the area scheduled for agricultural clearing between 1972 and 1982.

3.4.2.1 Bukit Ibam Integrated Forest Complex

This project, already incorporated has potential for a sustained yield operation of Sawmill and Remanufacturing facilities in conjunction with a plywood operation utilizing 5,000,000 cu. ft of round wood anually. A potential for expansion into particle board and fully finished component parts exist after proper product and market research is completed.

The proposed Bukit Ibam Forest Complex will require 100,000 forest tons annually, with the plant coming into production in 1975. The proposed conversion plant will be supplied from areas scheduled for agricultural clearing for the initial operating period 1972 to 1980 with an extension of 3 years available. An area of 42,000 acres of virgin forest is necessary for the pre 1980 period and has been allocated as follows:

Year	Acreage	Tons/acre logged	Volumes		
			Sales	Utilized	Total
1972/3	8,300[1]	12	102,000	—	102,000
1974	5,000	12	60,000	—	60,000
1975	6,000	15	40,000	50,000	90,000
1976	6,700	15	—	100,000	100,000
1977	6,000	17	—	100,000	100,000
1978	5,000	20	—	100,000	100,000
1979	5,000	20	—	100,000	100,000
TOTAL	42,000		202,000	450,000	652,000

[1] Study Paper No. 9 "Proposed Bukit Ibam Industrial Forest Complex".

[1] Made up of MARDI and townsite clearing acres.

The change over to harvesting in the T.F.L. is predicated on the successful testing of the intensive forest management system at the Lesong Complex in the previous years. It should be recognised that 2 years is not the best duration to prove out a system which is based on a 5-year rotational cut. However, it is felt that, in the interests of expediency, enough *may* be known about the system during 1978 and 1979 to justify its application at the Bukit Ibam T.F.L. in 1980. However, if more time is needed before harvesting commences in the T.F.L. then further areas in the

Jeram Valley could be logged economically to protect the Bukit Ibam operation. This option is discussed in Section 4.3.3 since it relates to the reassignment of the balance of other areas. Nevertheless if the logging programme for agriculture is behind schedule AND the agricultural programme is behind AND the intensive management system not yet proven—then the pre-1980 logging areas for the Bukit Ibam Timber Company could be extended in time only into the 1980's.

For the logging to be behind schedule would mean that the *industry* at Bukit Ibam was not on schedule. By 1980 it will be possible to determine the extent to which the complex has been able to phase in its various parts and therefore to make any adjustments to the design of its operations with respect to the T.F.L. which are appropriate. If everything has gone according to plan this will mean a complex comparable with that of Lesong, will be operational at Bukit Ibam in the early 1980's.

3.4.3 FMU 1 Bebar—177,000 acres

The area contains some 271,000 acres of *potentially* productive forest of which 177,000 acres at this time is considered to be manageable. An estimated 265 million cubic feet (5,310,000 forest tons) is contained within the manageable forest areas.

The species composition is ideal for furniture component part plant[1], however the area is presently undeveloped due to the lack of economic logging methods. The substantial size of this forest reserve and the utilization plants which the area could support warrants the establishment of experimental logging operations. Because such experimental work will be beyond the financial and technological capabilities of existing operators the Pahang Tenggara Authority should support and/or manage experimental studies along the lines suggested in Section 5.2 "Research and Development".

Assuming that development of logging techniques will allow the production of the resources in the swamp area by 1980 or sooner at economic costs per ton, a potential utilization system producing fully finished component parts could be established on the coastal highway.

The resources are indicated to be in a volume and specie range that leans to utilization in a fully finished component operation. The range of density and colour groupings indicate a resource suitable for fully finished component parts saleable predominantly in the United States.

Technological developments and environmental conditions are rapidly changing manufacturing methods in the United States furniture industry. In the past, furniture manufacturers purchased rough lumber from which they produced each respective furniture part. Today, the most modern and profitable furniture plants are those devoted to assembly and merchandising of furniture. Parts and sub-assemblies are purchased in the same manner as in the automotive industry. The purchasing of parts from speciality woodworking plants closer to the sources of raw material has been found to be more practical and profitable to furniture manufacturers and merchandizers.

Growth in the wood components industry in the United States will be in direct proportion to increase production in the furniture industry. Output of the furniture industry in 1975 is expected to reach $7.4 billion, an increase of 45% since 1969 level.

The total size of the present market for wood components in the United States wood household furniture industry has been estimated to be somewhere between $250 million and $290 million per year. Industry rationalization and production economics, as well as environmental and social conditions, all indicate that future raw material requirements of the furniture industry will be in the form of wood components.

Although transportation costs would form a high percentage of delivered value of primary lumber from a plant situated in Pahang Tenggara, because of the higher unit value of wood components as compared to rough lumber, transportation costs for components form a much lower percentage of delivered value. This would permit wood components form for example a Lanjut plant to reach markets beyond the economic range of lumber.

Malaysian wood component manufacturer, in exporting to the United States, must be prepared and capable of melting the rigid requirements of quality control and delivery schedules demanded by the industry. Under certain conditions the ability to meet the above criteria is far more important than the ability to sell the finished product at a low price.

The wood components are broken into three main categories i.e. a rough component, semi-machined components and fully machined components.

[1] *See* Section 4.2.2 and Appendix F Section 11.0.

Indications of the percentage share of the total components market for the three main categories are:

(*a*) Rough Components	20.9%
(*b*) Semi-Machined Components ...	47.4%
(*c*) Fully machined Components ...	31.7%
	100.0%

The following summary covers the investment details required for the physical plant. The detail of this potential industry is given in Section 11.0 of this volume.

Equipment	$ 6,201,000
Freight and Handling	937,000
Site and Services	201,000
Buildings	1,520,000
Installation	558,000
Engineering and Disbursements	1,140,000
Total ...	$10,557,000

Labour requirements for the Complex are summarized as follows:

Production	
Unskilled	76
Semi Skilled	116
Skilled	87
Highly Skilled	62
Technicians	84
Supervisors	31
Total ...	456

3.5 FORESTS TO BE LIQUIDATED—1972-1980

There are over 660,000 acres of forests, both virgin and disturbed scheduled for agricultural clearing during the years 1972 to 1980.

Table 3.5a—Areas Scheduled for Agricultural Development 1972-1980
(Acres)

Block	*Virgin*	*Disturbed*	*Non Forest*	*Total*
I LOGGING COMMITTED:				
Mentiga	39,200	25,700	3,100	68,000
Teriang and Bera	7,300	62,800	35,400	105,500
Keratong	100,900	76,700	19,400	216,200
		19,200[1]		
Lesong West	4,400	62,800	51,100	118,300
Logging Committed Sub-Total ..	151,800	247,200	109,000	508,000
II LOGGING NOT-COMMITTED:				
Lesong South	11,800	—	—	11,800
East	6,100	24,500	—	30,600
Rompin—Aur	71,500	8,300	—	84,000
		4,200[2]		
Bebar	6,000	24,000	—	30,000
Logging Not-Committed Sub-Total..	95,400	61,000	—	156,400
GRAND TOTAL ..	247,200	308,000	109,000	664,400

1 Marginal virgin forest calculated at 5 forest tons/acre.
2 Riverine type, virgin, calculated at 5 forest tons/acre like disturbed forest.

The areas scheduled for clearing shown in Table 3.5a are equal to a conservative volume of round wood based on a 12 tons[1] per acre (average 15 tons from virgin forest—5 tons from logged over forests) to be disposed of during this clearing programme amounting to 5,710,000 tons on an eight year schedule:

1972/73	695,000 T
1974	695,000 T
1975	720,000 T
1976	720,000 T
1977	720,000 T
1978	720,000 T
1979	720,000 T
1980	720,000 T
Total ...	5,710,000 T

The possible markets for the round wood resources available from these areas can be considered in the following groups:

A. Singapore

B. Existing operations on periphery of Pahang Tenggara Area

C. Complexes within Pahang Tenggara.

3.5.1 Singapore

The Singapore timber industry has been a steady and influential customer for disposal of unprocessed resources of the Pahang Tenggara area and could still be considered as a market to be supplied up to 1980. However, the Singapore market will be influenced by the higher grade and less expensive logs of Indonesia that could enter the market in volume from 1974 onward.

This volume of superior raw material from Indonesia will have a tendency to decrease the price commanded by Pahang Tenggara round wood and also the volume.

On the premise that the existing industry in Singapore, which in the past has been a market principally for high grade log from Pahang and will increasing its future supply of "high grade" resources from Indonesia, the importance of Singapore as a volume outlet is expected to decline sharply in 2 or 3 years and possibly reduce to a token level.

[1] 1 ton (T) equivalent to 50 cubic feet of timber.

3.5.2 Existing Operations

Approximately 68 round wood conversion operations exist in Pahang and northern Johore, around the periphery of the Pahang Tenggara area. It is estimated that these operations, based on existing conditions, will require approximately 748,000 T (@ 50 cu. ft. per ton) annually of round wood.

Included in the 68 operations are 8 plywood plants that consume approximately 184,000 tons annually of round wood. It should be realized that the plywood operations use only high grade logs of fairly large diameter, and limited species. Thus it is estimated that only 4-5 tons per acre are suitable for this operation. If the high grade logs are taken from the overall saleable volume of the resources, the marketing of the balance becomes quite difficult and usually involves reducing both the number of species and their price.

None of the sixty existing sawmill operations have production facilities to dry and further remanufacture the resources into finished products. It is estimated that only 13 existing operations in Pahang have the production and capabilities to expand. Only 2 and possibly 3 operations are known to draw their present resource requirements from the Pahang Tenggara area. In addition to the two complexes and peripheral existing operations, a future resource utilization system is planned by Mentiga Forest Products whose plant would be located outside the region but whose resource consists of 102,000 acres within Pahang Tenggara. Although agreements with the State involve firm commitments by this company, no detail planning or implementation of the manufacturing facilities has been made public. However, the operation is understood to be based upon production for 20 years, taking 60,000 forest tons @ 50 cu ft per ton per year. The logging programme is designed to work the first 14 years in virgin timber and the last 6 years in disturbed forest areas of the concession. All lowland forest areas after logging will be released for agricultural development.

A special opportunity will also be discussed in Section 4.0.1 in relation to the existing concession at Ladang Pegawai which has the presently unrecognised potential to operate a special complex similar to those which are suggested to utilize "excess" timber resulting from the agricultural clearing programme.

It can only be assumed that due to the large volume of round wood to be generated by the agricultural development plan up to 1980, any

programme of enforcing greater utilization on the existing operators will be extremely difficult. Round wood supplies up to 1980 are available from the committed lands but after 1980 as the agricultural development nears completion, resources outside the Pahang Tenggara area will have to be made available if these 68 operations are to survive.

3.5.3 Special Complexes within Pahang Tenggara

In the event that existing industries do not utilize the wood supply coming from the clearing operation through the lack of suitable conversion facilities, it is proposed that integrated wood utilization plants or special plants be established within Pahang Tenggara. Based on the total agricultural clearing programme for the region these plants would have a 15 year capital write-off period. The estimated balance of 935,000 tons of such "excess" resources would support three "special" complexes that could possibly come into production in late 1974, 1975 and 1976.

A technical feasibility study of such a complex is provided in Section 10 of this report. Each operation would include a sawmill, pre Dry-Kiln drying facilities and a planer moulding operation. Total investment in each operation would be approximately $5,500,000 to $6,000,000 depending on site requirements. Increased marketing ability in Malaysia of fully finished wood products will enable new manufacturing systems to profitably utilize smaller and lower grade commercial species and a larger variety of so called secondary and under-utilized species.

It should be understood that 3 such complexes are *possible* with this volume of resource, but the degree to which other "claims" will be made on these sources of supply by industries outside the region is not known. Thus the siting of one, two or all three of these new plants should be finalised after this situation is clarified. Any or all of these complexes could be established in central locations in the Lanjut area within a reasonable trucking distance from the resources. This location has the advantage that the economic life of the plants can be extended beyond 1980 by ongoing agricultural clearing required in that area. The volume of resources available would then be sufficient for a maximum of 17 years operation assuming the first unit becomes operational in the middle of 1974.

If this course was implemented, these three units could be managed by a central management team. Each producing unit would be under the direct control of a production superintendant answering to the authority management team consisting of the following personnel, based on a schedule of service to suit the implementation of the Special Complex:

(1) General Manager
(2) Marketing Manager
(3) Comptroller
(4) Plant Engineer
(5) Mechanical Engineer
(6) Electrical Engineer
(7) Planer-Moulder Machineman
(8) Shipper—Marketing Co-ordinator
(9) Production Supervisor
(10) Saw Doctor
(11) Production Sawyer.

3.5.3.1 Special complexes allocation

The balance of the areas within the Aur Forest Reserve, adjacent areas to the east in the Bebar block, and East of Endau-Rompin Park have been grouped together because the forests are so located as to be capable of supplying conversion plants located in the Rompin-Lanjut area. Here, plants would have access to both ocean transport and the main north-south coastal highway. It should be recognised however that the potential for these plants is based on assumption that the existing industries fail to utilize the same sources of timber. The following description shows how all three plants could operate from the total resource, however depending on the reaction of existing manufacturers less than 3 plants might be implemented.

The area remaining after the allotment to the Bukit Ibam Complex consists of 55,000 acres of virgin forest and 46,000 acres of disturbed forest as shown in Table 3.5b.

Table 3.5b—Aur Forest Reserve, Adjacent Bebar Area, and East of Endau-Rompin Park

	Virgin	*Disturbed*	*Total*
Aur Forest Reserve:			
Bukit Ibam Allotment	42,000	—	—
Non alloted	43,000	—	—
	85,000	—	85,000
East of Aur Forest Reserve	6,000	22,000	28,000
East of Endau-Rompin Park	6,000	24,000	30,000
Total ...	97,000	46,000	143,000

Assuming useable wood potential at 15 tons per acre from virgin forests and 5 tons per acre from disturbed forests, and the unallocated total of 1,055,000 tons is available from these areas between 1972 and 1980. Averaged over the 8-year period, this volume is capable of supporting plants utilizing 130,000 tons annually.

It is proposed that these wood volumes be allotted to three special complexes phased into production in 1974, 1975, 1976, with each plant utilizing 36,000 tons annually. Logging should commence during 1972/3, at a reduced rate, with logs produced in excess of requirements sold as roundwood.

The proposed complexes would use a total of 55,000 acres virgin timber and 24,000 acres of disturbed forest until 1980.

The remainder of the Aur Forest Reserve agricultural clearing area is allocated for the proposed Complexes in the following Table:

Table 3.5c—Allocation of Resource to Special Complexes

Year	*Virgin Forest*	*Disturbed Forest*	*Sales*	*Volumes in Tons Complex*			
				I	*II*	*III*	*Total*
1972/3	4,000	3,000	75,000	—	—	—	75,000
1974	6,300	3,000	92,000	18,000	—	—	110,000
1975	7,500	3,000	71,000	36,000	18,000	—	125,000
1976	7,500	3,000	35,000	36,000	36,000	18,000	125,000
1977	7,500	3,000	17,000	36,000	36,000	36,000	125,000
1978	7,500	3,000	17,000	36,000	36,000	36,000	125,000
1979	7,400	3,000	17,000	36,000	36,000	36,000	125,000
1980	7,300	3,000	17,000	36,000	36,000	36,000	125,000
Total ..	55,000	24,000	341,000		594,000		935,000

Areas assumed to produce 15 tons per acre from virgin forests and 5 tons from disturbed forests.

After 1980, the 3 proposed complexes could obtain a minimum of 10 years annual wood requirements from the area East of Endau Park from areas to be cleared for agriculture.

Other areas (east of Aur Forest Reserve in Bebar Block) remaining of the 1972-80 agricultural clearing schedule total approximately 24,000 acres of disturbed forest. This area has a potential of 110,000 tons, which could supply the existing plant in Rompin or could be sold as round wood.

3.6 FOREST ADMINISTRATION AND MANAGEMENT ORGANIZATION

Within the limits of the State Forest organization, the following organizational changes are suggested for the management and administration of the forests within the study area.

3.6.1 Administration

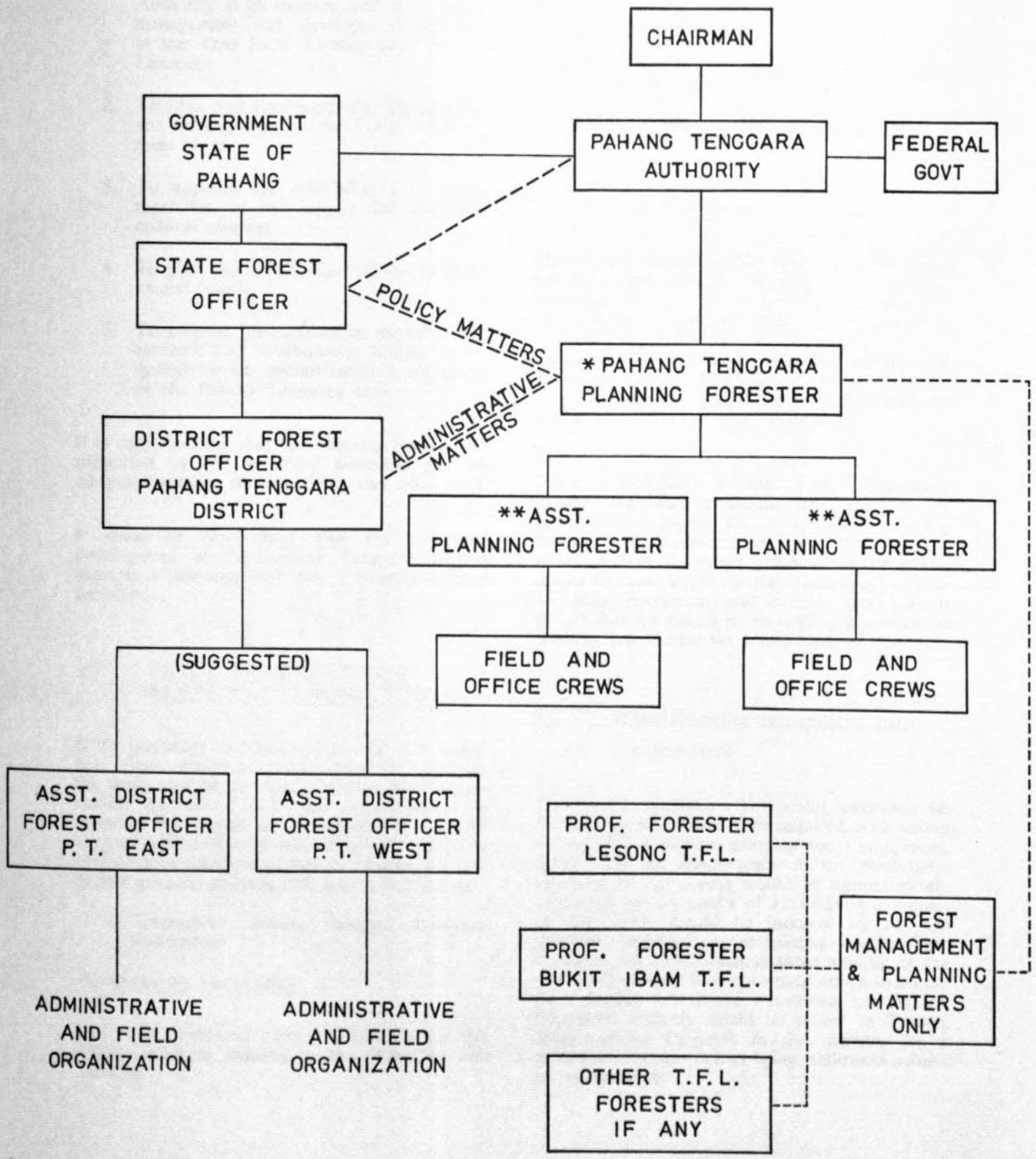
It is considered to be of prime importance that the Pahang Tenggara Study area be organized into one forest district under the administration of one District Forest Officer (with one or more assistants) directly responsible to the State Forest Officer. The uniformed staff required to perform the normal administrative functions would be organized in the usual manner.

3.6.2 Planning and Management

As the planning of the management and development of the forests is of prime importance in the overall development of the Pahang Tenggara Region, it is considered that a function of Planning Forester on the staff of Pahang Tenggara Authority must have high priority.

It is recommended that the Planning Forester should be directly responsible to the Pahang Tenggara Authority and liaise with the State

Proposed organization for Forest Management and Administration of Pahang Tenggara Study Region.



* EXPATRIATE PERSONNEL

** EXPATRIATE PERSONNEL WITH COUNTERPARTS

Forest Officer on policy matters and with the District Forest Officer on administration. The duties in brief of the Planning Forester will be as follows:

1. To represent the Pahang Tenggara Authority in all matters concerning forest management and development planning in the Tree Farm Licence areas by the Licensees.
2. To plan and implement the management and development of the Forest Management Units.
3. To approve the scheduling and implementation of the logging for the agricultural clearing.
4. To plan the development of the environmental forests.
5. To propose, recommend or request forest research and development studies as required for the overall forest management of the Pahang Tenggara area.

It is recommended that the Planning Forester be supported by two or more assistants and an adequate number of field crews and office staff.

It must be emphasized that the scheduled development of the Pahang Tenggara Region requires a planning staff that is functional from the start.

3.7 SKILL TRAINING FOR MANUFACTURING UNITS

If the preceding recommendations for new industrial plants are to be implemented on schedule, the study analysis has indicated that shortages of skilled personnel will be experienced. To minimise this impact on the schedule this section suggests a co-ordinated programme that could be promoted as standard procedure. Training in the timber products industry falls into two categories:

(*a*) Theoretical training through classroom instructions.

(*b*) On the job training.

The most important aspect of training for the timber products industry is the "On The Job Training".

3.7.1 **Theoretical Training in the Classroom**

This type of training would cover three separate subjects.

(*a*) Saw Doctor

(*b*) Woodworking Equipment & Maintenance Procedure

(*c*) Timber Identification & Grading.

3.7.1.1 Saw Doctor

The course would be for approximately three months and would require a competent instructor. A class of approximately 12 students at one time is suggested. Most of the operations in Malaysia utilize bandsaws up to 7 and 7 inches in width, but new complexes utilize wider bandsaws—10, 11, 12 inches in width. A choice will have to be made between Japanese or North American teaching equipment.

Upon completion of the basic Theoretical Course, the student should be placed in an operational complex for a further 3 months training and familiarization with the practical issues of Saw Doctoring, after which he would return for two weeks to the Theoretical Course for final instruction and exams. The student should then be placed in an existing operation as Trainee Saw Doctor for a minimum of one year.

3.7.1.2 Woodworking equipment and maintenance

This course requires a competent instructor on the making of various tools required, and setting up and use of various grinding room equipment, along with the maintenance of the machinery. Duration of the course would be approximately 4 months and an intake of 12 students is recommended. This should be followed by an "On The Job Training" in an existing woodworking operation for approximately three months, at the end of which time students would return to school for a further one month instruction and exams. Successful students would be placed as Trainee Woodworking Operator in the industry for a period of one year before being confirmed subject to performance.

3.7.1.3 Timber identification and grading

This course would follow through the existing courses being carried out by the Malaysian Forestry Department. The first part; Timber Identification, would cover approximately three weeks. This Timber Identification Course should become mandatory for all trainees in the lumber industry as it would give a basic training in the value of the products they are all working with as well as a general appreciation of timber and its various aspects.

Upon completion of the Timber Identification Course a Timber Grading Course by the Forestry Department would require from nine to twelve weeks. This course would emphasize practical work and should be carried out both in the schools and in existing lumber operations as "On The Job Training" until certified as to grading standards established by the Forestry Department of Malaysia.

3.7.2 **General**

The following further training courses are necessary in the timber industry.

(*a*) Industrial Mechanic Courses leaning heavily to the requirements of the lumber and plywood industry.

(*b*) Mobile equipment Maintenance and Driving Courses which would cover the area involving straddle Trucks and Lift Trucks.

(*c*) Lumber Drying (which would have to take place in existing operation due to the high investment of equipment) could be given by the existing vocational school.

Other than the highly specialized trainees in the three main categories (3.7.1) these other programmes would constitute "On The Job Training" within in the existing operations. Since the training of people within the commercial operation is very expensive, the firms participating in "On The Job Training" programmes could only do it on a reimbursement payment basis.

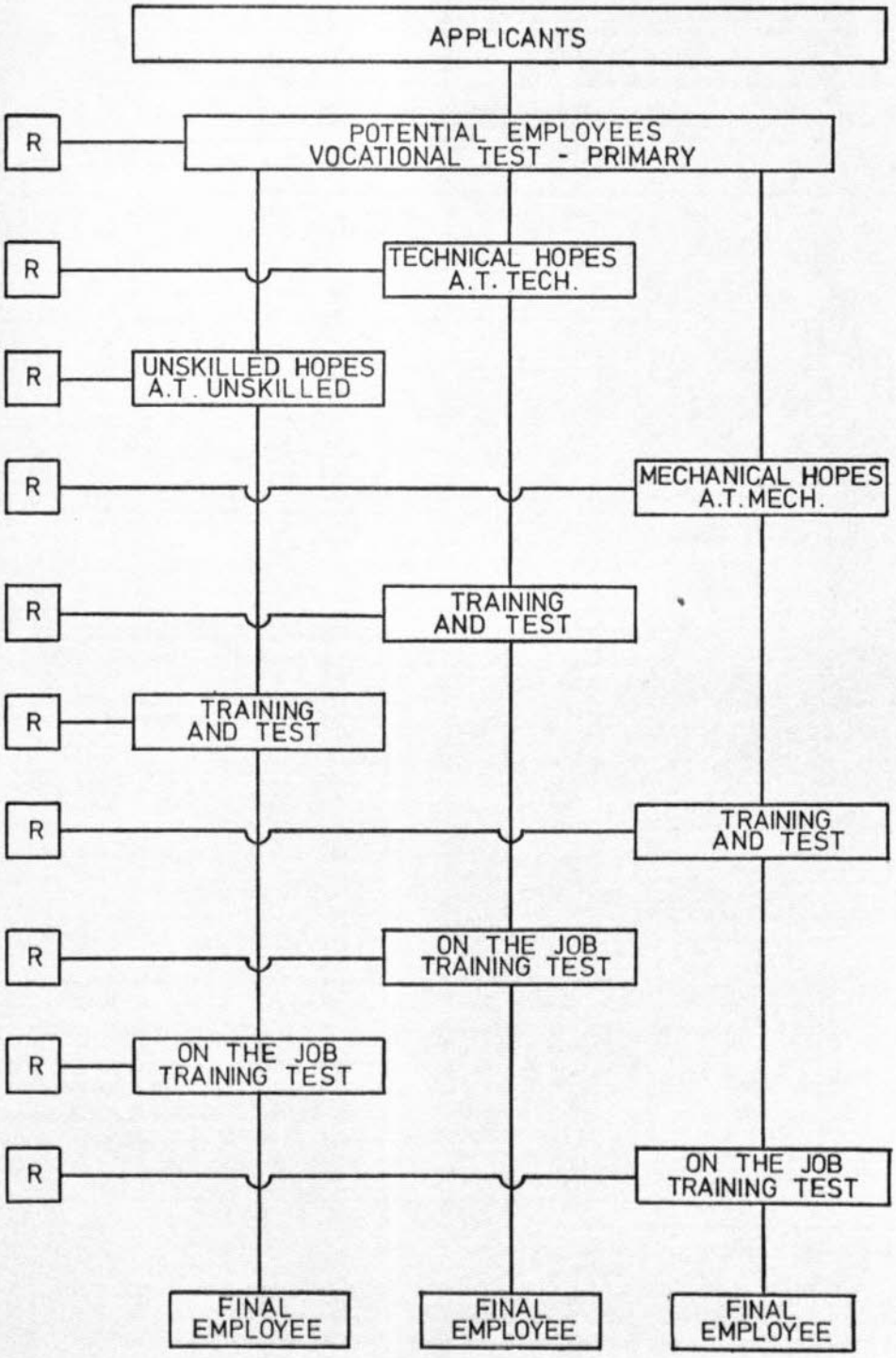
Trainees in the lumber and plywoods industry must accept the fact that they will be manual workers and not administrative staff. Years of practical experience in the industry are necessary before executive status can be achieved. The calibre of the instructors and the co-ordination between the training programme itself and the industry is of prime importance. The selection of trainees is vital to the success of the course and it is suggested that aptitude tests become a standard part of trainee selection. Figure 3.7 illustrates the various facets concerned in the co-ordination of a total programme.

The age group of trainees should be from 17 to 27 years old and with Lower Certificate of Education as the minimum qualification. The trainees should be paid sufficient allowance so as to allow them to live reasonably (Suggest $70-$100 per month).

The Forestry Training School in Belimbing was reviewed for possible use in the overall training programme. However a detailed investigation indicates that the operating costs and total investment far exceeds the values required to establish a training unit of the type previously described. The available equipment, at Belimbing is not felt to be sufficiently practical to give a long term indication of the Timber Industry in Malaysia. The Malaysian Timber Industry, in particular, the industry in the Pahang Tenggara region, will require close liaison with the Department of Labour and the national programme as a whole. It is possible that the training courses will require expatriate instructors for a minimum of two years in the Saw Doctor and Woodworking Courses. Overall co-operation and co-ordination between Industry and Government is vital to the survival of any training programme both from a practical and financial standpoint.

Fig. 3.7

FOREST INDUSTRY MANPOWER TRAINING



A.T. : APTITUDE TEST
R. : REJECT

4.0 FOREST DEVELOPMENT OPTIONS

The masterplan for the development of Pahang Tenggara has established that 1980, between the Third and Fourth Malaysia Plan periods, is a critical point for reappraising the overall plan. In addition to the routine monitoring of progress which has been going on as described in the supporting report "Organization and Implementation of Pahang Tenggara Development" there will be an examination of the basic assumptions and forecasts which were used in the original cost benefit analysis to determine the relative positions of forestry and agriculture in the masterplan.

Thus the following sections will discuss the options which could result from *changes* in basic assumptions or forecasts since the plan would otherwise remain as described in Section 3.0 There is only one real option open in the pre-1980 and that relates to the committed areas destined for agricultural development.

Within this committed area lies the largest single commitment, the Ladang Pegawai Concession which warrants special consideration because of its unique status as an area committed for agricultural clearing, but due to its size and quality of timber has the potential for a forest industry.

4.1 LADANG PEGAWAI CONCESSION

The Ladang Pegawai Concession contains an estimated 50,000 acres of virgin forest which is scheduled for clearing. Assuming that a conservative 12 tons (600 cu. ft.) per acre is removed, a total of 600,000 tons will be produced from the area between 1972 and 1980. This will average 75,000 tons per year, more than ample volume to supply sizeable conversion plant.

A special complex utilizing 36,000 tons per year is described in Section 3.5. If the contract covering the Ladang Pegawai Concession area can be renegotiated to recognize this industry potential then 36,000 tons per year could be committed to such a plant.

Assuming that a special complex is established to utilize the resources generated from the Ladang Pegawai area by the clearing programme up to 1980, resources for a minimum operation of 10 more years will be required since one of the prerequisites of Ladang Pegawai establishing an "industry" would be a guarantee of round wood resources for a minimum period of 17 years as discussed in Section 4.1.2.1.

In theory the clearing schedule could be extended beyond 1980 to provide 36,000 tons per year for at least 15 years from the Ladang Pegawai Concession area alone. This option however should be preserved as part of the overall masterplan review scheduled for 1980 (*see* 4.2.1.2).

The timber volumes would be allotted as follows:

Year	Acreage	Sales	Volume-Tons Utilized in Complex	Total
1972/73	6,250	75,000	—	75,000
1974	6,250	75,000	—	75,000
1975	6,250	57,000	18,000	75,000
1976	6,250	39,000	36,000	75,000
1977	6,250	39,000	36,000	75,000
1978	6,250	39,000	36,000	75,000
1979	6,250	39,000	36,000	75,000
1980	6,250	39,000	36,000	75,000
TOTAL ..	50,000	402,000	198,000	600,000

This allocation assumes only 12 tons per acre stand utilization a conservative estimate.

It is possible that the 1981-1990 resources could possibly be available from the agriculture clearing programme, due to slower implementation than planned. However FMU No. 3 is located adjacent to this area and therefore a review of options schedule in 1980 should include this resources as available to the Ladang Pegawai complex when considering both the operating life and the type of industry planned at this time.

The 1980 planning should then be considering the following questions:

(*a*) Does the next 10 year resources requirement of Ladang Pegawai come from agriculture clearing or from FMU No. 3?

(*b*) Are sufficient resources available to allow Ladang Pegawai to expand its manufacturing systems for a longer time if it so desires?

(*c*) If Ladang Pegawai decides not to expand and there are sufficient resources left in the agriculture clearing areas to sustain Ladang Pegawai till 1990, how are FMU No. 3 resources utilized?

Based on existing utilization standards, the 110,000 acres that makes up the FMU No. 3 has a utilization resources volume of 60,000,000 cu. ft. (1,200,000 tons at 50 cu. ft.) approximately. Assuming that utilization standards will improve by 1980, a potential of a 50% increase in volume utilizeable is anticipated. This would increase the resources in FMU No. 3 to approximately 90,000,000 cu. ft. (1,800,000 T—50 cu. ft.).

FMU No. 3, as a managed resource for use after 1980, would allow the Government, State and industry to establish a Forest Resource Policy allowing survival of efficient operations in Pahang. The Government, State and industry would have six years to establish the policy which would be directed towards:

(*a*) Stimulating the immediate improvement of existing industry through facilitating the modernization and/or expansion of those plants which have growth potential.

(*b*) Encouraging increased manufacturing of higher value products, initially through kiln dried, fine sawn, surfaced and manufactured timber.

(*c*) Furthering the establishment of secondary and tertiary processing industries.

(*d*) Securing an adequate supply of resource, sufficient to permit the continued life of economically viable enterprises, in Pahang.

4.2 DEVELOPMENT STATUS AT 1981

The major part of the agricultural clearing programme will have been completed by 1980, if the proposals made for the 1972-1980 period have been implemented. Table 4.1a summarizes the status of land areas within the Pahang Tenggara Study Region at the beginning of 1981.

Table 4.1a—Status of Forestry Programme in 1981

Total Agricultural Development 1971-80		664,000 acres
Maximum Agricultural Commitment after 1980		285,000 acres
Areas under Development as Permanent Forests:		
Lesong T.F.L. Area	116,000	
Bukit Ibam T.F.L. Area	120,000	
FMU 1—Bebar	177,000	
		413,000 acres
Park Reserves:		
Tasek Chini	9,800	
Tasek Bera	76,200	
Endau-Rompin	78,700	
Coastal Sands	1,800	
Mangrove Tidal Reserve	15,400	
		181,000 acres
Balance of Area After Maximum Agricultural Development:		
Productive Forest	272,500	
Non-Productive Forest	456,000	
Non-Forest	243,500	
		942,000 acres
Total Area		2,485,000 acres

Table 4.2a—Area Development 1980+

Block	Hill Forest	Lowland Forest	Riverine Forest	Total Productive	Marginal	Seasonal Swamp	Permanent Swamp	Edaphic Hill	Total Non-Product	Non-Forest	Total
AGRICULTURE AND FORESTRY OPTIONS:											
Teriang—Bera	—	123,900	—	123,900	—	—	—	—	—	13,500	137,400
Lesong—East	—	91,000	5,400	96,400	—	—	—	—	—	—	96,400
Rompin—Aur	—	46,000	—	46,000	—	3,000	—	—	3,000	2,800	51,800
Sub-total ..	—	260,900	5,400	266,300	—	3,000	—	—	3,000	16,300	285,600
STATUS AFTER MAXIMUM AGRICULTURAL DEVELOPMENT—ACRES:											
Mentiga	34,800	—	—	34,800	—	20,200	1,000	600	21,800	1,900	58,500
Teriang—Bera	71,100	36,900	—	108,000	2,300	17,400	—	2,400	22,100	81,100	211,200
Keratong	5,200	—	—	5,200	—	11,500	—	—	11,500	—	16,700
Lesong West	7,800	—	7,000	14,800	—	—	—	—	—	—	14,800
Lesong East	46,500	100	9,400	56,000	5,400	12,800	3,600	3,200	25,000	7,600	88,600
Rompin—Aur	30,300	200	—	30,500	200	19,400	4,200	200	24,000	23,500	78,000
Bebar	10,100	12,700	400	23,200	15,500	8,000	328,200	—	351,700	99,400	474,300
Sub-total ..	205,800	49,900	16,800	272,500	23,400	89,300	337,000	6,400	456,100	213,500	942,100
Total ..	205,698	310,800	22,200	538,800	23,400	92,300	337,000	6,400	459,100	229,800	1,227,700

Table 4.2b—Proposed Forest Area Development after 1980

	Hill Forest	*Lowland Forest*	*Marginal Forest*	*Riverine*	*Seasonal Swamp*	*NF*	*Total*
FOREST DEVELOPMENT:							
FMU 2. Chini—							
Mentiga Block	18,000	—	—	—	—	—	18,000
Teriang-Bera Block ..	26,700	33,300	2,300	—	17,400	—	79,700
Rompin-Aur Block ..	17,000	—	—	—	—	—	17,000
Total ..	61,700	33,300	2,300	—	17,400	—	114,700
FMU 3. Godam—							
Teriang-Bera Block (includes Edaphic Hill, non-productive, 2,392 acres)	46,700	64,700	—	—	—	—	111,400
FMU 4. Kelantong—							
Teriang-Bera Block ..	—	37,000	—	—	—	—	37,000
Sub-total Forest Development	108,400	135,000	2,300	—	17,400	—	263,100
AGRICULTURAL DEVELOPMENT:							
1. Teriang-Bera Fringes in 3 parcels	—	25,900	—	—	—	13,500	39,400
2. Lesong-East, 11 parcels..	—	91,100	—	5,300	—	—	96,400
3. Rompin-Aur Jeram Valley (including H.H. Concession)	—	42,000	—	—	—	—	42,000
4. South of Bukit Ibam, 2 parcels	—	4,000	—	—	3,000	2,800	9,800
Sub-total Agricultural Development ..	—	163,000	—	5,300	3,000	16,300	187,600
Total ..	108,400	298,000	2,300	5,300	20,400	16,300	450,700

4.3 NEW POSSIBILITIES

In the event that cost benefit analysis review to be performed in 1980 favours forestry landuse over the balance of the agricultural development programme, then two Forest Management Units could be established as shown in Tables 4.2a and b and also on Figure 4.2.

4.3.1 Forest Management Units

The two following FMU's summarized in Table 4.2b, contain areas with marginal potential for agriculture development. These lowland forest areas when combined with surrounding hill forests produce units with the potential sustained yield management as permanent forests. Without the addition of the lowland forests, the potential for developing the hill forests alone will be seriously restricted.

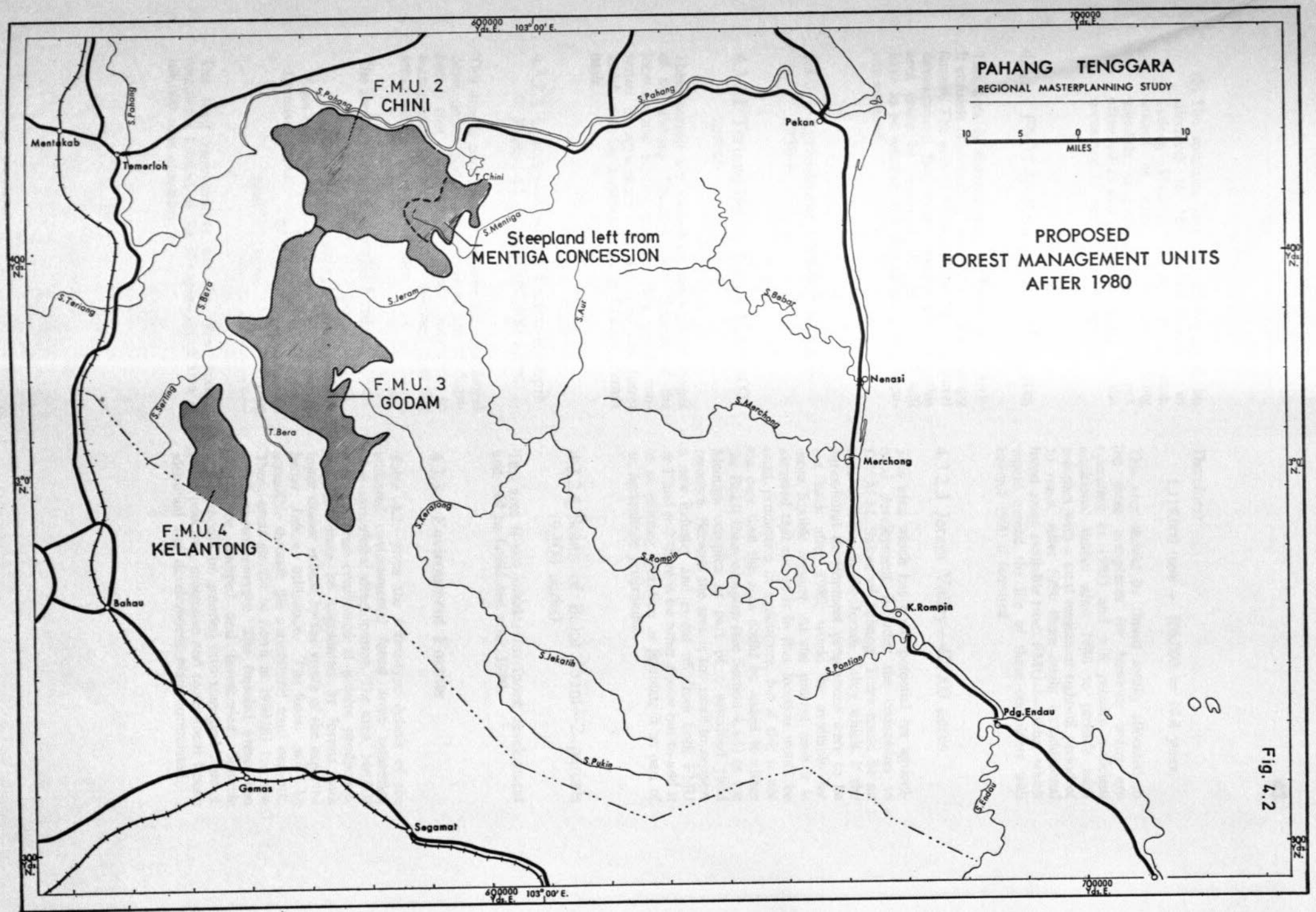
4.3.1.1 FMU 2 Chini—114,700 acres

This area is adjacent to the Mentiga Concession and has the potential for a sustained yield capacity to maintain a forest complex. It is logical that this area can be allocated to the Mentiga operations for development after the present Mentiga Concession expires some time after 1980. The allocation of the FMU 2 however must be conditional on the continuous operation of a forest complex with satisfactory utilization capabilities.

4.3.1.2 FMU 3—111,400 acres

This area is located east from the Tasek Bera Park and is accessible mainly from north-west. The southern part is also accessible from Ladang Pegawai area. This area could be allocated as follows:

(*a*) To be turned into Tree Farm Licence with potential similar to that of Lesong T.F.L.


PAHANG TENGGARA
REGIONAL MASTERPLANNING STUDY
10 5 0 10
MILES
PROPOSED
FOREST MANAGEMENT UNITS
AFTER 1980
F.M.U. 2
CHINI
F.M.U. 3
GODAM
F.M.U. 4
KELANTONG
Steepland left from
MENTIGA CONCESSION
Mentakab
Temerloh
Pekan
Nenasi
Merchong
K.Rompin
Pdg.Endau
Bahau
Gemas
Segamat
S.Pahang
T.Chini
S.Mentiga
S.Teriang
S.Bera
S.Jeram
S.Aur
S.Bebar
S.Sering
T.Bera
S.Merchong
S.Keratong
S.Rompin
S.Jekatih
S.Pontian
S.Pukin
S.Endau
103° 00' E.
400000 Yds. E.
700000 Yds. E.
Fig. 4.2

(*b*) The southern part (say 30,000 acres) be allocated to the special complex in Ladang Pegawai if such a complex existed at 1980 and if the clearing schedule in Ladang Pegawai were not extended to provide timber supply for the necessary 15 years write-off period.

4.3.1.3 FMU 4—Kelantong—36,900 acres

This area is situated west of Tasek Bera Park. It consists of disturbed forest on a rather swampy terrain. The area is not scheduled for agricultural development. Before any specific plans for this area could be proposed, the forest stand will have to be rehabilitated and its productive capacity assessed.

4.3.2 Agricultural Clearing Areas—1980+

4.3.2.1 Teriang-Bera—3 parcels (39,400 acres)

These parcels are located on the western fringes of the Pahang Tenggara area. Because of the location and existing clearings they will be converted to agriculture and the remaining forest stand will be liquidated on a Cutting Permit basis.

4.3.2.2 Lesong—East of Endau-Rompin Park—11 parcels (96,400 acres)

This area is under heavy pressure for agricultural development and the forest areas are so distributed that they do not lend themselves to management as a unit. It is assumed that the areas will be cleared after 1980.

The area contains the following forest:

	Acreage	*Volume/ acre*	*Total Volume*
Virgin Forest	62,600	15	940,000
Disturbed Forest ...	22,300	8	179,000
Total ...	84,900		1,119,000

The total requirements for the three special complexes located in the Rompin-Lanjut area is 108,000 tons annually.

Therefore:

1,119,000 tons ÷ 108,000 = 10.4 years.

This area should be almost totally allocated to the three complexes (or however many are operating in 1981) and will provide sufficient additional timber after 1980 to provide each complex with a total minimum right-off period of 15 years. After 1990 there might be additional forest areas available from FMU 1—Bebar which would extend the life of these complexes well beyond 1990 if required.

4.3.2.3 Jeram Valley—42,000 acres

This area which has good potential for agricultural development includes the concession to D.Y.M.M. Sultan of Pahang. There could be an area of forest in the Jeram Valley which, if the agricultural development programme were to be cut back after 1980, would be available for more flexible logging. At the present time it is assumed that the soils in that location would be most productive in agriculture, but if this is not the case then the area could be added to either the Bukit Ibam complex (see Section 4.3.1) or the Mentiga complex as part of a sustained yield resource. Because the area is too small to support a new industry and is cut off from both FMU # 1 and # 2 there is no other choice but to add it to an existing operation or liquidate it as part of an agriculture programme.

4.3.2.4 South of Bukit Ibam—2 parcels (9,800 acres)

This area is not suitable for forest development and will be liquidated after 1980.

4.3.3 Environment Forests

Table 4.2*c* gives the forest-type details of the scattered environmental forest areas remaining after agricultural development. The area, 146,000 acres of forest considered at present productive, may in future be augmented by forests with lower timber values, by the virtue of the expected better future utilization. The forest will be accessible through the agricultural road network. These areas should be flown in 1980/81 for new aerial photo coverage. The forested areas then should be mapped and inventoried. Suitable blocks should be grouped into manageable units, the productive, protective and recreational forests identified and development plans formulated.

Table 4.2c—Environmental Forest Areas after 1980

Block	*Hill Forest*	*Lowland Forest*	*Riverine Forest*	*Total Productive*	*Marginal*[1]	*Seasonal Swamp*	*Permanent Swamp*[2]	*Edaphic Hill*[3]	*Non-Product*[4]	*Forest*[5]	*Total*
Mentiga	16,800	—	—	16,800	—	20,200	1,000	600	21,800	1,900	40,500
Teriang—Bera	—	—	—	—	—	—	—	—	—	81,100	81,100
Keratong	5,200	—	—	5,200	—	11,500	—	—	11,500	—	16,700
Lesong West	7,700	—	6,900	14,700	—	—	—	—	—		14,700
Lesong East	46,500	100	9,400	55,900	5,400	12,800	3,500	3,200	24,900	7,600	88,400
Rompin—Aur	30,300	200	—	30,500	200	19,400	4,200	300	24,100	23,500	78,100
Bebar	10,100	12,700	500	23,300	15,500	8,000	328,300	—	351,800	99,400	474,500
Total ..	116,600	13,000	16,800	146,400	21,100	71,900	337,000	4,100	434,100	213,500	794,000

[1] At sometime after 1980 these areas might become productive.
[2] Basically wildlife reserve—some areas adjacent to productive forest might be included into developed forest.
[3] Protection Forest—Hands off.
[4] The concept of non-productive may change after 1980.
[5] Mostly under Orang Asli cultivations or interference.

5.0 RESEARCH AND DEVELOPMENT

Research and development in the forest products industry of Malaysia covers three separate fields of activity each relying on the other for success, i.e.

— Forest research and development.

— Product research and development.

— Market research and development.

All of these fields should be joint ventures by Federal and State Governments and the forest industry as a whole. The basis for a successful research and development programme is the Forest Research Institute at Kepong. The Pahang Tenggara study has undertaken initial work in both product and market research and development. The product research is documented in Appendices G, H and I while the market analysis is presented in Appendix J to this report. The following section summarizes the work of the study at Kepong.

5.1 FOREST RESEARCH AND DEVELOPMENT

5.1.1 Plantations

Preliminary studies have been carried out in cooperation with the staff of the Pilot Plantations for Quick Growing Industrial Tree Species Project, Forest Research Institute at Kepong, regarding the establishment of pilot plantations. Areas in both the proposed Lesong T.F.L. area and adjacent to the proposed Bukit Ibam T.F.L. area were selected for the establishment of pilot plantations and a suggested development programme with a list of recommended species to be planted was included. The following pilot plantations were recommended.

Bukit Ibam — 24 acre plot on Pohoi Soil Series.

— 26 acre plot on Durian-Marang Soil Series.

— 6 acre plot on Malacca Soil Series.

Lesong Area — 26 acre plot on Rengam Soil Series.

— 26 acre plot on Durian Soil Series.

The following tree species are recommended for trial plantings:

Pinus caribbaea	Pinus Oocarpa
(Honduras pine)	(Oocarpa pine)
Pinus Merkusii	Araucaria cunninghamii
(Merkus pine)	(Hoop pine)
Araucaria Klinkii	Sample plots of other
(Klinki pine)	species

It was further recommended that the Honduras and Klinki pines be subject to fertilizer trials. The plantations as suggested above should be started within the Lesong T.F.L. area under terms of the T.F.L. contract agreement.

When the Bukit Ibam proposed T.F.L. area is covered by a similar agreement, the pilot plantations as suggested should be established.

The information gained through the pilot plantation projects in the Lesong and Bukit Ibam T.F.L. areas will have application towards the management of forest areas elsewhere in the Pahang Tenggara Study Region. Certain limited areas of disturbed forest may lend themselves to the establishment of fast growing tree species plantations but the major potential for the establishment of plantations is considered to be in the rehabilitation of abandoned agricultural lands.

5.1.2 Swamp Forest Experimental Logging Operations

The determination of economic logging methods for the successful exploitation of the Bebar swamp forests should be concentrated on the following phases:

(*a*) access, which is presumed to be the building of the necessary road system within the swamp forest area and

(*b*) yarding and skidding which is the assembly of the logs at the road access system ready for transport

(*c*) cable system.

5.1.2.1 Road construction techniques

With the swamp forests lying more or less along the ocean, the vast quantities of sand which is on the beaches would form the logical road building material.

Construction techniques using sand can only be learned through trial and error, for example condroy and sand. Sand has the ability to support considerable loads when in a wet condition. With a very high water table in the swamp areas, there is the possibility that the correct level of sand, kept moist by the water in the swamp will provide sufficient support to carry log transportation vehicles.

The use of inexpensive chemical additives (similar to soil cement techniques) may be an alternative to stabilize the road surface and enable supporting standard logging trucks.

It is most probable that a combination of sand roads, constructed at minimum cost and the use of special log transport vehicles equipped with oversize wheels and tyres with low ground pressure will produce the best cost factor. The logs would be reloaded from these special trucks onto conventional highway logging truck units for transport to the conversion plants, where the sand roads reached the standard heavy duty road system.

When it has been determined what is required to produce a satisfactory access road into the swamps, then various road building techniques should be experimented with to produce the lowest costs.

Conventional methods using front end loaders, dump trucks and machinery for spreading, all specially equipped to operate on the sand, would be capable of building the roads but not necessarily at the lowest costs. One possibility is the use of special dredging equipment to pump the sand from the beaches in light, easily handled pipelines. This system may have some decided cost advantages, and may be worth investigating if the necessary equipment for experimentation purposes is available at reasonable rental cost.

5.1.2.2 Yarding and skidding

Very little is known about the ground conditions underlying the swamp forests. The actual ground cover, and what underlies the soft upper soil levels will determine the skidding methods which have the best chance of success. It is known that the ground conditions vary and that some areas are drier, more solid and hence more promising for the use of mobile log skidding equipment; others are very wet and soft and may be suitable only for cable systems.

Mobile Log Skidding

There are various types of skidders available for use on soft ground, these are:

— Low ground pressure crawler tractors, which are equipped with very wide track pads and extra long trucks. These machines can operate both with and without a log arch, the use of which restricts machine manoeuvreability somewhat but reduces track ground loading pressures.

— Wheeled skidders, equipped with very large floatation tires and designed for soft ground use.

— Tracked Log Skidders which are in the development stage and operate similarly to a wheeled skidder (articulated steering) but run on tracks instead of wheels. They have been designed to operate in much softer ground and require much less skid trial preparation than wheeled skidder units. These vehicles, although more expensive than a wheeled skidders appear to offer much promise for logging in the swamps.

All three of these machines have possibilities depending upon the ground conditions. The wheeled skidders, however, would best be operated in combination with a tracked machine capable of rendering resistance and preparing skid tracks.

Experiments will have to determine the machines which are capable of operating under the various ground conditions; the skid trial preparation necessary (such as corduroying soft parts with small wood and saplings and how many times the machines can traverse the same skid trail without the trail becoming impassable.

The economical skidding distance will depend not only on the capabilities of the machine but also on the cost of building suitable roads. The cheaper the road cost the shorter should be the yarding distance.

For experimental work the following machines are suggested which may be fairly easily available and could be leased:

— Cat D6, Cat wide track machine. There are local dealers who would most probably be willing to support in some measure the experimental use of these machines.

— Wheeled Skidders, floatation tires. Although it is doubtful if the floatation wheel equipment is available locally, it may be possible to get the co-operation of a local dealer in so equipping of some wheeled skidder units for experimental work.

There are two such machines made in Canada, which are currently available. These are:

— Bombardier Trackmaster, manufactured in Quebec, Canada, equipped with a 130 hp engine and costing CDN $35,000 approximately.

— Foremest Tracked Log Skidder, manufactured in Calgary, Alberta. A heavier duty machine than the one above with 185 hp engine and costing CDN $50,000 approximately.

If the experience with the wide track crawler and floatation tired wheel skidder show promise, but areas of operation are found to be limited, investment in a Tracked Log Skidder for experimental purposes may then be warranted and would probably receive some support from the manufacturers.

5.1.2.3 Cable system

Any of the mobile log skidder units requires ground conditions which will support the vehicle, conditions which may not exist for a substantial portion of the Bebar swamp forests. Cable logging systems, which are not restricted by ground condition other than by terrain and topography may have application in these areas.

Hi-Lead Cable Yarding Systems

The volume of wood recovered per acre is a much more critical factor with cable systems than with mobile log skidders, and recoverable volumes on the Bebar forests would appear to be marginal for high capital cost cable skidding units.

Yarding distances for most mobile cable yarding systems will be limited to a maximum of 1,200 ft. with economical yarding distances somewhat less. Although cable systems are best suited to clear cut logging systems, they are capable of operating in selective systems.

Existing mobile hi-lead cable yarding units have capital costs from US$110,000 to US$250,000 which necessitates a very high productivity to produce economic unit yarding costs. Such systems are dependant upon a well developed road system to provide access throughout the areas to be logged.

It would appear that these units are much too highly capitalised to produce realistic yarding costs. The use of these mobile cable systems may be feasible if capital costs can be reduced through purchase of used units, or by the use of simplified units much less sophisticated. Their use, however, will be dependent on the construction of a low cost road system, and experimental work will not be warranted until low cost road building techniques are established.

Sky-Line Cable Systems

In use in some areas is cable systems similar in design concept to a ski-lift, and which will reach considerable distances, in some cases 5,000 ft. Trees can be used for intermediate support of the sky-line, and as the equipment is light, hand methods can be used for installation procedures. The major disadvantage of this system is that the wood recovered could be suitable only for the manufacture of particle board, chips and pulp.

5.1.3 Recommendations

With such a large area involved, which by 1980 will be the largest uncommitted forest resource remaining in the Pahang Tenggara Study Region, and possibly in Pahang State as well, it is considered that the Government support is warranted and will be returned in both direct and indirect revenues when the Bebar swamp forests are being utilized. It is recommended therefore that the Pahang Tenggara Authority assisted by other Government Agencies subsidize and/or conduct these logging experiments.

5.2 PRODUCT RESEARCH AND DEVELOPMENT

Early in the formative stages of the Pahang Tenggara Masterplanning Study, it was decided to include a programme of applied research at Forest Research Institute on three production areas of the wood products industry of Malaysia. The basic objective of this applied research was to stimulate industrial operating practices in the field of plywood, component parts and particle board furnish. The applied research was carried on over a period of 14 months by three specialists in the above areas of operation.

The Forest Utilization Section was concerned with all species found in the Pahang Tenggara area, but their experimental programme was attuned to species of lesser or no current commercial value. This was necessary in order to conduct a suitable analysis within the allotted study period.

The Kepong Forest Research Institute has specific data on many Malaysian species and maintains a programme to supplement this information. Their approach, however, of necessity tends to favour more basic or fundamental characteristics of the woods, and while this is of unquestionable scientific interest and value in providing the explanations why different woods behave as they do, it is too involved for the investor-businessman whose technical concern, is merely "Would the species be satisfactory for the service intended?" The experimental programme undertaken by the Forest Utilization Group was designed to find some answers to this question. It took the more direct course of investigating potential products, and their production systems, with the objective of presenting viable integrated operations involving secondary manufacturing processes. Secondary industries not only provide greater employment opportunities but also substantially increase the value of the input log. Captive secondary industries provide a means for introducing new species to the market place, and where combined operations are maintained, manufacturing economics can be effected by:

(*a*) avoiding duplication of service facilities

(*b*) selective distribution of raw material for maximum return

(*c*) waste utilization within the complex.

5.2.1 **Plywood** (Appendix G)

Despite the fact that the Forest Research Institute at Kepong has conducted studies and successfully prepared some sixty indigenous species or subspecies into veneer and plywood, the industry shuns all but a few. This restrictive policy is attributed to:

(i) the ready market acceptance of presently used species.

(ii) the ready availability in quantity of presently used species.

(iii) an owner/manager reluctance to accept the risk of increased processing and market development costs for new species.

5.2.2 **Particle Board** (Appendix H)

Practical particle board preparation had not previously been undertaken at the Forest Research Institute prior to the arrival of the Pahang Tenggara Wood Utilization Study team, but two major pieces of equipment had been ordered in June 1969 in preparation for such studies. One of these, the mixer, arrived in mid-October 1970, the Flaker arrived on April 2, 1971.

Two references were found related to particle board studies involving Malaysian species, Vere Engineering Co. Ltd., of London have apparently prepared samples from rubber trees, Kempas, Balau, 80% Red Meranti and 20% Balau and other species within the last 5 to 7 years. Reit-Holsverwertungsanlage of Germany has also prepared laboratory boards from Meranti Kepong, Merawan, Kedondong, Penarahan and Durian.

The preparation of particle board entails the intimate mixing of particles (shavings, flakes etc.) with a thermosetting resin in economic proportions so that the mixture, when spread in a mould, then pressed at elevated temperatures, will retain its pressed shaped and dimensions as a result of the curing (setting) of the resin. The quality of boards is influenced by both furnish and processing factors.

Particle board has at least five major applications: floor underlayment, sub-flooring, exterior cladding, coreboard and paint grade. Each of these has specific requirements in order to be acceptable, though specifications differ somewhat in different countries. Perhaps the most common application of particle board is as coreboard, where it forms the substrate for thin surface veneers, and this combined board is used extensively in radio and T.V. cabinets as well as in interior partitions in both domestic and commercial buildings. It is the development of this grade that the experimental programme has as its primary objective.

5.2.3 **Component Parts** (Appendix I)

Component parts manufacture involves a variety of operations including turning, planing, milling, boring, sanding and wood finishing. Each of these must function satisfactorily for a species to become acceptable. Forest Research Institute staff had discussed various woodworking characteristics of a number of air-dried Malaysian

species, however, they limited their classification essentially to satisfactory or unsatisfactory. Since the purpose of testing is to classify according to degree of usefulness or service these properties which may be significantly influenced by processing equipment and conditions, another extensive series of woodworking operations was conducted in which the scales of classification were expanded. This broader range permits greater selectivity of species and processing for those charged with the decision-making responsibility in a component part factory designed to compete in current world markets.

A component part factory is an assembly line type of operation producing a multiple of wood parts of identical design suitable to be assembled into furniture of various designs and styles.

5.2.4 Product Research and Development Needs

Although the forest industry has made appreciable advances in its technology in recent years, the industry will need major technological advances in the coming decades if it expects to meet the increase competition from synthetic materials, to continue to market a reasonably priced product, and to continue to operate in an environment which is increasingly conscious of the problems resulting from pollution.

The forest products industry, in particular the pulp and paper section, has had a long history of co-operation in research and exchange of technical information. This tradition is not unique to any country in particular, but is common to virtually every forest product producing country in the world. Malaysia, through the Forest Research Institute at Kepong has also benefitted from this system.

The impact of a breakthrough in present day industrial research is insignificant compared to the significance of the industry's ability to exploit it. However, in Malaysia and indeed the world forest industry today, there is a large number of marketing problems that need solving. Yet the researcher should not have his activities limited by such constraints.

While recognizing that pure research is important, the results must be applicable to be justified in a commercial or marketable sense. The co-operation of marketing and technology is essential but it is even more crucial that technology and the industry work together.

Consequently, it is important that the industry relay to the researcher its own goals and priorities. Further, it is important that industry learn in which areas research and development can play its most useful role. The development of an industrial research programme within the forest industry of Malaysia should include the industry and both Federal and State Governments. The Forest Research Institute at Kepong is the essential basis on which a successful programme can be built.

A successful and profitable research and development programme in Malaysia would be determined by a number of input factors, i.e.:

(*a*) Industry requirements and acceptance of a programme

(*b*) Government forestry and utilization policis

(*c*) Research facilities and staff

(*d*) Research management.

5.2.4.1 Research Programme Committee

The vehicle for a well organized and active Research and Development programme for the forest industry in Malaysia could be the establishment of a Research Programme Committee. The Research Programme Committee would consist of members of industry and government. It would meet annually (more if required) and would be chaired by the Director of the Forest Research Institute.

The objects of the Research Programme Committee would be:

(*a*) To review annually the research programmes and make recommendations relating to Forest Research Institute programme content, allocation of resources, and changes in programme emphasis or direction.

(*b*) To submit annually to the Forest Research Institute new technical problems requiring research and to participate in discussions regarding research priorities.

(*c*) To provide a direct channel of communication between research staff and industry and Government in order to promote more effective research and greater application of research results in industry.

All members of the Research Programme Committee should be technically and managerially competent people who accept the responsibility of ensuring that they are putting forward the views of the various segments of industry they represent. Due to the diversity of interests, knowledge and experience required by members of the Research Programme Committee, it must be assured that the members understand the technical subject matter and are deeply involved in the forest products industry, both on Government and private level.

The Research Programme Committee would establish Sub-Committees with each covering a major area of work based on industry requirements. Each Research Programme Sub-Committee would have a chairman chosen by main Committee's Directors with Forest Research Institute supplying Sub-Committee secretaries.

The members of each Research Programme Sub-Committee would be chosen by the Sub-Committee Chairman and approved by the Research Programme Committee Directors. Each Sub-Committee would meet quarterly to review all the Forest Research Institute projects in their particular area of responsibility and to recommend project priorities.

The *advantages* of setting up a Research Programme Committee and a number of Sub-Committees are:

(1) One committee enables industry to speak as a single, unified voice about Forest Research Institute research programmes and projects, and thus avoid conflict and misunderstanding between Forest Research Institute and Industry.

(2) It would enable Forest Research Institute to assemble the most knowledgeable and experienced people in a given field of work, in Malaysia. These experts could act as sounding boards for Forest Research Institute, thus leaving more time for the laboratories to spend on solving existing technical problems or projects.

(3) It would protect Forest Research Institute from outside pressures of small minority groups or minor short-term projects of doubtful value to the industry. Requests for doubtful technical work could be reviewed by an appropriate sub-committee at the discretion of the Forest Research Institute Director.

(4) It would help to improve communications between Forest Research Institute and industry by:

(*a*) Keeping Forest Research Institute better informed of industry's real needs and problems.

(*b*) Enabling industry to be more aware of a project progress and whether or not their recommended problems, ideas and project and programme priorities have been accepted.

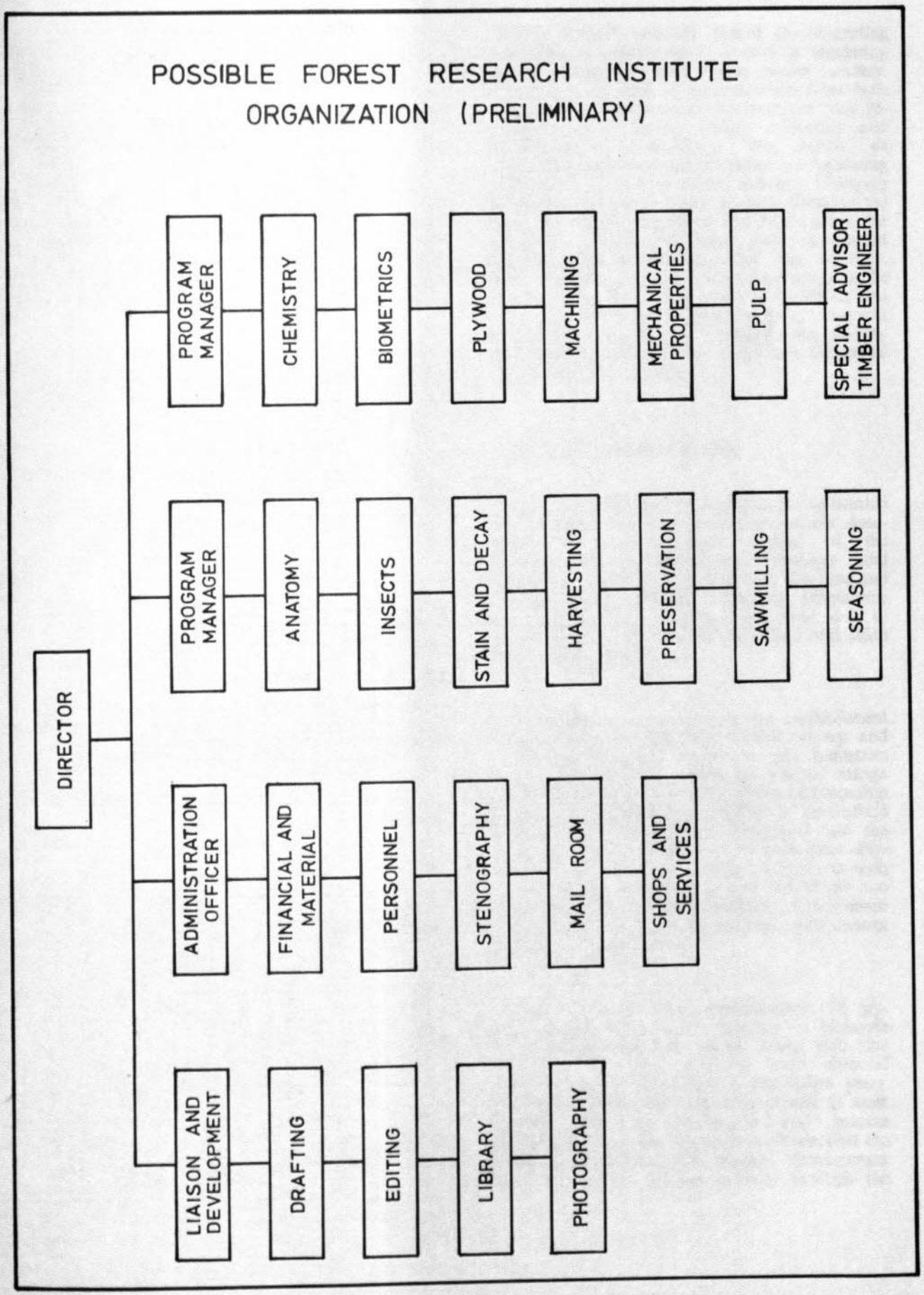
The disadvantages of setting up a number of sub-committees is that this could increase the work load of Forest Research Institute staff. However, the great improvement in communications between industry and the Forest Research Institute would certainly make it well worthwhile.

The recommendations of the Research Programme Committee would be received by the management officials of Forest Research Institute who together with the Forestry Department co-ordinator arrive at tentative decisions to accept, reject or defer. In practice there would be a high level of acceptance. After further study including cost-benefit analysis as may be appropriate, a working plan is evolved and a research commitment is undertaken.

The policy of the Forest Research Institute should be that it does not compete with commercial testing facilities and further, that it will not undertake projects on behalf of a single company. On the other hand, if the laboratory is in the position (as frequently happens) that it is the only testing organization equipped to do some specific task, then it will do this for a single company and charge for it. Rates should be set to cover the cost of the project. In other cases, where the laboratory is engaged in a project which it considers will benefit the industry as a whole and finds it expedient as part of the project to carry out a specific piece of research at one company's operations, it will provide that company with the results on a confidential basis and at no charge. The majority of research undertaken by the Forest Research Institute is felt to be in the public interest and therefore is financed out of general revenues.

Attached organization chart could possibly fit into a Forest Research Institute and industries closely co-ordinated research and development programme.

Fig. 5.2


POSSIBLE FOREST RESEARCH INSTITUTE
ORGANIZATION (PRELIMINARY)
DIRECTOR
PROGRAM MANAGER
CHEMISTRY
BIOMETRICS
PLYWOOD
MACHINING
MECHANICAL PROPERTIES
PULP
SPECIAL ADVISOR TIMBER ENGINEER
PROGRAM MANAGER
ANATOMY
INSECTS
STAIN AND DECAY
HARVESTING
PRESERVATION
SAWMILLING
SEASONING
ADMINISTRATION OFFICER
FINANCIAL AND MATERIAL
PERSONNEL
STENOGRAPHY
MAIL ROOM
SHOPS AND SERVICES
LIAISON AND DEVELOPMENT
DRAFTING
EDITING
LIBRARY
PHOTOGRAPHY

5.3 MARKET RESEARCH AND DEVELOPMENT

The wood products industry in Malaysia will, over the next decade, be required to change not only its manufacturing polices, but also its marketing policies.

Marketing in the future will not be an entity by itself but will be part of a wholly integrated industry beginning at the standing timber through the manufacturing systems, onto the means of transportation, up to the door of the customer.

The traditional sawn timber operation in Malaysia has been the small sawmill that produces and sells rough sawn air dried boards and planks. The sawmillers have relied on volumes of "creamed logs" purchased by the lorry load from concession holders. Only the larger logs and logs of limited species have been harvested and attempts have been made only to buy the highest quality. Depending on the content of meranti logs in any particular area, approximately 25% or 35% of the timber volume in any particular concession has been harvested.

Certain re-manufacturing facilities for further processing of the rough air dried sawn timber have been occasionally set up but these have tended to be separate units that would in turn buy the rough air dried lumber from the individual sawmills. These remanufacturing facilities dry the lumber down to approximately 8 to 10% moisture content and then re-produce it into finished material such as S4S boards, mouldings, door jambs and similar high valued products.

The margin of profit in the wood industry rises dramatically as the various steps in re-manufacture take place. The North American and European concept has been to have integrated industries that control the timber, harvested through to the manufacturing facilities, and then remanufacture the produced material through to its ultimate useage. In addition, the purpose of these facilities is to utilize as much of the material as possible by remanufacture and disposing of defects by utilizing a particular piece of wood in such a way and to get the ultimate out of the raw material. This must become the objective of the Malaysian forest industry.

This approach to utilization will require Market Research and Development to a degree never before practised in Malaysia. The Malaysian Timber Export Industry Board (Incorporating Act 1966) is considered as a start in regulating and improving the sawn timber export industry. The board consisted of representative from both Singapore and Malaysian Governments plus representatives of various timber exporting and manufacturing associations. This board, as originally conceived, was primarily for regulating purposes in the timber export industry. Changing marketing conditions could possibly decrease the need for industry regulating and would allow the board to become the focal point of market research and development for the industry. Although sales of sawn timber products must be the responsibility of the producer, guidance and assistance in product acceptance by overseas markets, through technical programmes, advertising and publicity are all vital ways the board could assist the industry.

5.3.1 **Plywood Industry**

The plywood industry of Malaysia is represented by the Malaysian Plywood Manufacturers Association. The association's control of the producers is manufacturing standards and marketing programmes is limited at this time and the Malaysian plywood marketing programme has suffered in the United Kingdom due to intense competition between individual Malaysian plywood manufacturers.

The association is considering the establishment of a Centralized Marketing Board to try and bring stability and control to the industries marketing programme. With the gradual change in the traditional agency distributor relationship in the United Kingdom market, a centralized Marketing Board could be developed into the main marketing association of Malaysian Plywood Products. One of the main dangers in such a Centralized Marketing Board would be too much government control. Basically, Government backing and blessing is required but with control within or by the industry.

As of September, 1971, approximately 28 plywood plants make up the industry in Malaysia and three proposed new plants. Along with nine plants in Singapore, a fairly large plywood capacity must be marketed in the future years. The plywood industry cannot stand still. It must expand, both in production and market acceptance to survive. There is no doubt that the product promotion and market development work carried out by the industry through the

medium of its trade association can contribute substantially to this growth. The industry must also benefit from assistance provided by Government at both Federal and State levels.

A programme of promotion should be formed with four main objectives in view:

(1) To secure treatment for Malaysian plywood consistent with its potentialities, in the Building Codes, and Building Standards throughout Australia, U.S.A., England and Europe.

(2) To overcome restrictions against Malaysian plywood based on its supposed vulnerability or weakness in relation to other plywood suppliers.

(3) To develop and establish an acceptable grading standard for the Malaysian plywood industry.

(4) To draw up suitable plans for promotion of Malaysian plywood through advertising and publicity.

Implicit in this programme should be the wish to avoid unnecessary duplication of effort and expense by pooling resources in attaining objectives manifestly beneficial to the whole industry. Little progress can be made if the members do not have both a common product, and objective to achieve. In fact, there is a common product in name only and it will take many months of discussion before the association can reach agreement on an industry standard.

The biggest point of discussion will be grading. An issue will be the important underlying consideration of available log supply and it will have a very significant bearing on the attitudes of the members. It is a fundamental issue which must be resolved if the association is to be effective. It is hoped the companies and the Government concerned will be basically convinced of the value of association work and no doubt will be influenced by the outstanding success of the Douglas Fir Plywood Association in the United States, and the Plywood Manufacturers Association of British Columbia, Canada.

The association should be founded on the establishment of a common industry grading standard and a common industry grade mark. The next step should be an industry quality control service with industry certification of grade. Strong representation to the members along these lines should be made as the association's promotional efforts will be hindered by the absence of proper grade certification procedures.

The Plywood Association could be financed by assessments on the members at a fixed rate per thousand sq. ft. of production. Reporting of production monthly can be on the honour system. Perhaps an audit of production records could be considered. The assessment rate is set each year to yield sufficient revenue on the estimated production for the ensuing year to carry out programmes budgetted for that year. The association can accumulate small surpluses which could be used to defray overhead expenses during the occasional times when income declines but surpluses should never be allowed to grow to the point where federal tax authorities became interested.

Each member company would be represented on the board of directors of the association and meetings could be held monthly. There should be one vote per member regardless of production volume. All issues, including the grading standard, should be resolved by unanimous agreement. This procedure should preferably evolve and should not be incorporated in articles or by laws. All plywood manufacturers in the country should belong to the association and should actively support it. The operating staff of the association, which eventually could reach 50 in number should be organized into three departments, advertising and publicity, field and technical. Staff members should all be specialists. Members views toward the programmes of the three departments can be made known through frequent committee meetings participated in by staff as well as representatives of the members. Recommendations by the committees should be rectified by the board of directors.

5.3.1.1 Field department

The field department could consist of specialists (mainly engineers) resident in market areas of interest to the industry. Each representative would be charged with the responsibility of providing specifiers of building materials in his area with accurate information about the properties and uses of Malaysian plywood. He would also be required to maintain a close liaison with all government departments of interest to the industry and to report developments having a bearing on the acceptance and use of Malaysian plywood. Association fieldmen should in no way be involved in the actual sale of plywood since

their primary task is to help to achieve a favourable climate for the product so that the regular sales organizations of the members would encounter minimum resistance.

5.3.1.2 Advertising department

The advertising department would prepare and release promotional material using all media. The promotional material should be based on information received from the field department and also on information developed by the technical department. Because of the nature of the product the emphasis in association promotional material should be on construction and commercial uses. Publications and paid space advertisements will be as factual as possible, and quite technically oriented.

5.3.1.3 Technical department

The technical department of the association should concern itself with development of new uses for the product, primarily structural applications. Initially, time should be spent in adapting technical data published by various associations and competitive manufacturing countries so that it would be suitable for use with Malaysian plywood. Procedures for designing with plywood have been published by many forest products laboratories. These procedures, combined with physical constants obtained by analysing lay ups used by Malaysian plywood manufacturers and with allowable working stresses for solid wood published by various sources could be put together into data for foreign designers. Liaison with the Forest Research Institute at Kepong could assist in refinements in this published material.

Association research activities should always be product-oriented. The industry should always look to the Government Laboratories for research on manufacturing problems. With industry guidance Forest Research Institute, Kepong, could become a vital part of this industry by providing means for full scale testing of plywood structural components with spans up to 100 feet. As a result of work done in the laboratory, design methods for such components as plywood web beams, stressed skin panels, postal frames and plywood domes can be published, thereby providing the basis for a growing number of component uses in commercial industrial and institutional building projects in North America and Europe.

Government, or industry certification of plywood quality is now, or soon will be, required in the EEC countries. Faced with exclusions from construction related sales to these markets, the industry must make a move toward certification of quality by the association.

5.3.1.4 Promotion

Naturally, the association should engage in many other activities on behalf of its members, such as preparation and presentation of briefs to various government bodies on a variety of subjects such as domestic and foreign tariffs, freight rates, taxation, forest policy, pollution, etc. Obviously, representations made on behalf of an industry on matters of common interest receive more attention from government than briefs from individual companies.

Market development work should always be a high priority item with the association. Studies can be carried out both by association staff and by consultants retained by the association. The associations field staff would be used extensively to obtain day to day market information and also to report on longer terms trends. Specific studies of potential markets would be done, usually as a result of recommendations made by member company sales agents.

During the time that the association is trying to develop long range overseas markets, the advice and assistance of officers of the Foreign Trade Service can frequently be sought and obtained. Anyone from industry who is involved in export markets would agree that the commercial counsellors of the department of trade and commerce should almost without exception be extremely helpful and knowledgeable. Joint Industry and Department of Trade and Commerce promotional activities, such as timber trade tours and participation in foreign building exhibitions can be undertaken. In these ways, the industry will gain promotional mileage paid for in part out of public funds.

For volume markets, it is felt that the tropical hardwood industry should be looking to construction uses such as concrete form, subflooring, wall and roof sheathing and plywood structural components. Consequently, the suggested steps should be taken at once to prepare the basic data required for entry into the construction market at the correct volume and price.

These steps are:

(1) Strengthen the association.

(2) Agree on quality standards.

(3) Try to standardize lay-ups, or at least agree on limitations on species mixtures, panel thickness tolerances, number of plies for each standard thickness, maximum and minimum thicknesses for face, cross-band, core and centred.

(4) Establish industry quality control and certification of grades.

(5) Start accumulating test data from in-grade samples of plywood as produced following procedures now widely accepted in countries such as Canada, the U.K., Australia and the United States. This work could be done by the Forest Research Institute under industry guidance although some additional test equipment might be required.

(6) Derive and publish allowable working stresses based on the test data mentioned above and seek acceptance in building codes and regulations of countries concerned.

(7) If everything seems favourable, i.e. quality, level of working stresses compared to competition etc. proceed to promote construction plywood in world markets on an association basis.

5.4 MARKET ANALYSIS

Appendix J Section 15.0 of this volume contains a detailed market analysis for the Malaysian Wood Industry. The following comments are a summary and conclusions drawn from that study. The major world markets have been in a wood-deficit position for some time and this deficit will continue to increase.

A reduction in the movement of wood in log form, with the resultant increase in internal processing, is believed to be most necessary and, by the same token, inevitable if Malaysia is to become strong as an industrial force.

The present "simple" manufacture of roundwood into sawn lumber and raw plywood must, inevitably, progress to semi and completely finished items[1] to satisfy world demand and to return more foreign exchange.

Pulp and paper is not included in this study but the production of pulp chips would do much to utilize waste and improve the financial return to existing operations.

There must be "Industry-wide" recognition of the basic requirements for establishing and maintaining a position in world markets-quality-price and continuity of delivery.

A vigorous and unceasing marketing effort, by knowledgeable personnel is necessary to acquire and maintain a market position.

A closer liaison between industry representatives and the Forest Products Research Institute should be sought if end-uses for present commercial species are to be expanded.

A "crash programme" designed to investigate the properties of presently "lesser-known" species should be instigated at the earliest and the Government (P.W.D.) would initially be the prime consumer of products produced from these species.

New sawmills do not qualify for pioneer status, but it is suggested, that consideration be given to the inclusion of sawmills if they are part of a total forest complex. This would promote more complete utilization and would result in (*a*) an increased yield from forest thus increased revenue through royalties and (*b*) an improved foreign-exchange income.

[1] Mouldings, finished lumber, furniture components, particleboard, printed and overlaid plywood.

6.0 APPENDIX A

6.0 FOREST INVENTORY SURVEY SPECIFICATIONS AND PROCEDURES

The study area falls under the jurisdiction of three Forest Districts; the north eastern part under Kuantan, the north western part under Temerloh and the southern part under Rompin.

6.1 METHODOLOGY

For the expediency of the inventory survey the area has been divided into seven blocks shown in the attached key map. The blocks coincide to a great extent with natural physiographic divisions based on differences in the configuration of the terrain, drainage pattern and access pattern.

6.1.1 **Phases of Survey**

The forest inventory survey consists of the following phases:

— Photogrammetry, including mapping and photo interpretation to provide forest stratification.

— Forest sampling to provide adequate data on specie composition and volume in the various forest types (strata).

— Volume and defect study to provide comprehensive local volume tables.

— Office compilation which consists of the following:

Sampling Accuracy Analysis.

Volume Tables Compilation.

Stand Tables Compilation.

Stock Tables Compilation.

Analysis of Collected data.

Calculation of Areas.

Construction of representative summaries.

— Comprehensive reports.

6.1.2 **Photogrammetry**

The avaliable coverage of aerial photographs of the study area is at a scale 1:25,000. The photography was taken during the years 1965 and 1966. The flight lines run in south-north direction. The photography is on panchromatic film and the quality with reference to scale and parallelism of flight lines, forward and side overlap, cloud obstruction and picture resolution, is only fair to marginal.

The effective area on each photograph covers three square miles, more or less, depending on the accuracy of the scale and of the overlaps. As a result, some 1,300 photographs have been interpreted.

6.1.2.1 Preparation of Photographs

The forest typing and other planimetric information is transferred from the photographs to the base maps. A radial plotter is appropriate for the hilly terrain of the study area, and it provides sufficient control for the plotting of forest cover maps. The preparation of the photographs for use on the radial plotter consists of marking the principal points (centre points), and wing points, and the transfer of these points to the adjacent photographs. Detailed instructions with reference to the use of the radial plotter are found in the plotter's manual.

6.1.2.2 Mapping

Available topographic maps, of a scale 1:25,000 are used as base maps. The photo-centres are transferred to the base maps from the map manuscripts where available, or interpolated from the planimetric detail visible on air-photographs. Scale stable material is used for working base maps. After the transfer of the photo-information to the topographic maps, these are ready for reproduction.

6.1.2.3 Photo Interpretation

Photo interpretation is preceded by a reconnaissance of the area, both from the air and on the ground, for the interpreters to become familiar with major vegetation associations. The impressions from the air reconnaissance are related to an intensive study of the photographs under sterescopes.

It is imperative that every forest type be recognizable not only on the aerial photographs but also on the ground, therefore, a broad typing of the forest associations is applied. A minimum area of 100 acres is considered as an individual type, or no less than one square inch at a scale of 1:25,000. Smaller than this minimum vegetation associations is included into a surrounding type.

A guide to photo interpretation incorporating a code and a schematic diagram of forest types pertinent to the study area, is presented in section 6.3.

6.1.3 **Stratified Intentional Sampling**

6.1.3.1 Blocks

The study area is divided into blocks or apparent administrative sub units to have separate estimates for each block for planning purposes. The blocks coincide to a great extent with natural divisions based on configuration of the terrain, drainages and on the access pattern. There are, therefore, expected differences in the composition and volume of the forest stands between different blocks.

6.1.3.2 Stratification

The forest within the blocks is stratified on the air photographs, or subdivided into forest sub populations called strata or types, so that there would be more variation between the types than within them, to obtain a more precise estimate of the forest stand.

6.1.3.3 Sampling Method

The sampling method applied for the forest inventory uses variable plots in a layout referred to as "intentional". The layout is a compromise between the random method and systematic method. It incorporates features of both methods and yields realistic results at a reasonable cost. The sampling is carried out along lines or strips selected intentionally so as to obtain representative sampling of various forest types, and at the same time to use the limited access to the greatest advantage, that is to get the most information per time and budget allocated to the survey. There is no bias in the allocation of the strips as to the quality of the stand.

The sampling plots are located along the strip at predetermined intervals to avoid personal bias in the selecting of plots. For reasons of expediency, the strip pattern rather than the cluster pattern is adopted.

6.1.3.4 Allocation of the Sampling Plots

The stand and stock estimates in a heterogenous tropical forest benefit from oversampling which yields a more accurate representation of the distribution of species and diameter classes. Therefore, there is a tendency to oversampling in a forest economically more valuable, e.g., productive forest as against marginal forest, virgin forest as against selectively logged forest. To get the smallest standard error possible for a sample of n plots in a forest type, by sampling is more heavy in more valuable forest stands and in the types having larger coefficient of variations.

6.1.3.5 Control of the Number of Plots

Coefficient of variation and standard error is calculated during the sampling to assure that any specific forest type is not undersampled.

The minimum number of sample plots is calculated by the formula:

$$n = \frac{t^2 S^2}{E^2}$$

Where:

- n is the minimum number of sample plots required.
- t equals 2 for the 95 percent confidence.
- S is the Standard Deviation (or S^2 is the Variance).
- E equals .50. It is an approximation of a ten percent of the assumed average of the number of trees per sample plot, which is expected to oscillate around 5, taking under account all species and applying basal area factor of 20 square feet per acre.

6.1.3.6 Implementation

Interpreted and stratified aerial photographs were used for planning of the distribution of strips. The characteristics of the forest cover on the photographs selected for the layout of strips are

Fig. 6.1a

PAHANG TENGGARA
REGIONAL MASTERPLANNING STUDY

KEY MAP

SHOWING

FOREST INVENTORY BLOCKS

I MENTIGA

II ROMPIN MINE – AUR

III LESONG

IV BEBAR SWAMPS

V BERA

VI TERIANG

VII KERATONG

SOUTH CHINA SEA

Mentekab, Temerloh, Teriang, Bahau, Segamat, Pekan, Kg. Melayu, Bt. Ibam, Kg. Aur, Nenasi, Merchong, K. Rompin, Pdg. Endau

S. Pahang, S. Mentiga, S. Teriang, S. Jeram, S. Bera, S. Serting, S. Aur, S. Bebar, S. Merchong, S. Rompin, S. Keratong, S. Jekatih, S. Pontian, S. Pukin, S. Endau, Tasek Bera

400 Yds. N. · 300 Yds. N. · 3°00' N. · 600000 Yds. E. · 103° 00' E.

10 5 0 MILES 10 20

Fig. 6.1b

FOREST INVENTORY FLOW CHART

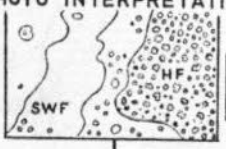
PHOTOGRAMMETRY & DRAFTING

PREPARATION OF PHOTOGRAPHS
PHOTO-CENTRES & WING POINTS, ETC.

FIELD WORK

FIELD RECONNAISSANCE

PRELIMINARY
PHOTO INTERPRETATION



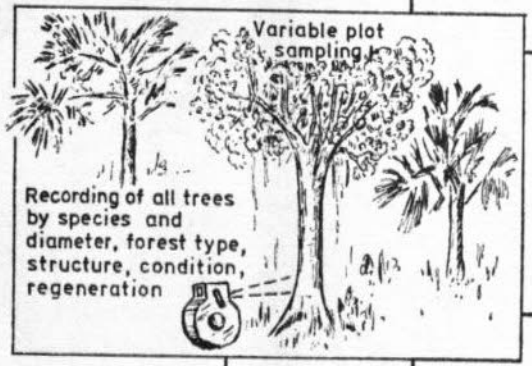
COMPILATION & ANALYSIS

FIELD ORGANIZATION
TRANSPORT-EQUIPMENT-SUPPLIES

DATA PROCESSING ORGANIZATION

STRIP ALLOCATION

BASE MAPS
CONSTRUCTION



SAMPLING ACCURACY ANALYSIS

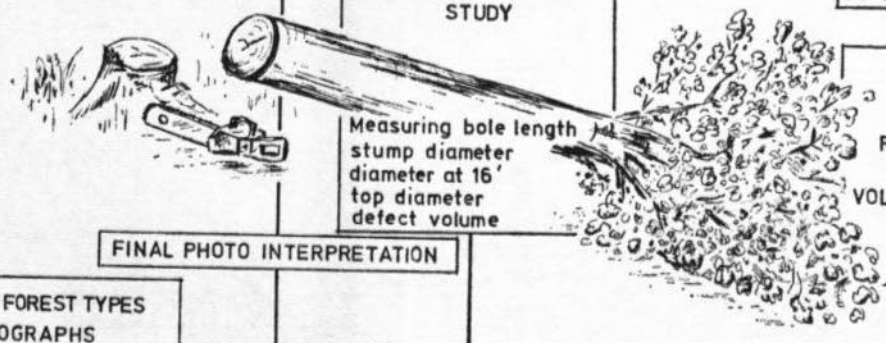
n	Σx	x̄	Σ(x²)	Σ(x)	SSR	MSR	SD	CV	SE

STANDARD DEVIATION
COEFFICIENT OF VARIATION
STANDARD ERROR

ADDITIONAL
SAMPLES

STAND TABLES
NO. OF TREES PER ACRE
BY SPECIES & DIAMETER CLASSES

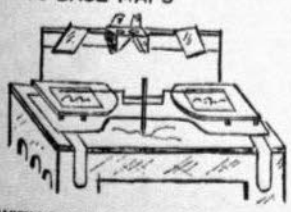
VOLUME & DEFECT
STUDY



COMPILATION OF
VOLUMES
REGRESSION ANALYSIS
VOLUME TABLE CONSTRUCTION

FINAL PHOTO INTERPRETATION

TRANSFER OF FOREST TYPES
FROM PHOTOGRAPHS
TO BASE MAPS



WITH RADIAL PLOTTER

STOCK TABLES
VOLUMES PER ACRE
BY SPECIES & DIAMETER CLASSES

FOREST COVER WORK MAPS
AREAS COMPILATIONS

FOREST INVENTORY REPORT
SUMMARIES
FINAL DEFINITION OF TYPES
ANALYSIS
ASSIGNMENT OF PRIORITIES
MANAGEMENT AND UTILIZATION PRECEPTS
CONCLUSIONS AND RECOMMENDATIONS

Fig. 6.1c

PAHANG TENGGARA
REGIONAL MASTERPLANNING STUDY

KEY MAP

SHOWING DISTRIBUTION OF

FOREST SAMPLING STRIPS

600000 Yds. E. 103° 00' E.

400 Yds. N.

3° 00' N.

300 Yds. N.

Mentekab
Temerloh
Teriang
Bahau
Segamat
Tasek Bera
Bt. Ibam
Kg. Aur
Merchong
Nenasi
Pekan
K. Rompin
Pdg. Endau
Kg. Melayu

S. PAHANG
S. Teriong
S. Bera
S. Serting
S. Mentigo
S. Jerami
S. Aur
S. Babar
S. Merchong
S. Rompin
S. Keratong
S. Jeka
S. Pukin
S. Pontian
S. Endau

SOUTH CHINA SEA

10 5 0 MILES 10 20

typical of the type under consideration. The point of commencement of the proposed strip was accessible and recognizable on the ground. A strip was a day's assignment for one crew. It was approximately one mile and one half long, or close to four inches long on the photographs of a scale 1:25,000. It was selected and plotted so as to be totally enclosed within the same forest type, away from the type's boarders to prevent the tallying of trees outside the type's boundaries. The distance between the plots along the strip was 400 feet.

For practical reasons a relascope was selected for tallying of the trees using a basal area factor of 20 square feet per acre. All trees of six inch diameter breast height and larger are recorded by species and by one inch diameter classes.

6.1.4 Volume and Defect Studies

During the survey some trees were felled, bucked and measured for volume and defect studies. To make these studies representative and significant to the survey, the trees to be felled were selected by the same methods as those used for tallying of trees. Furthermore, the compilation methods of these studies were the same as those used for the compilation of sampling data. To fulfil these requirements all trees in one, or better two sample plots in every strip were felled, measured and analysed. For practical reasons the first and/or second sample plots in every strip were subjected to this treatment.

Details of field crew organisation, sampling procedure, volume and defect study and the use of relascope are included in the following paragraphs.

6.2 FIELD COMPILATIONS

Field office compilations consisted of the following:

Sampling Accuracy Analysis.

Volume Table Construction.

Stand Table Compilation.

Stock Table Compilation.

Data Analysis.

Areas Calculation.

Sampling accuracy analysis was carried out during the field work. The rest of the compilations were carried out as soon as the field work in any particular block had been finished.

6.2.1 Sampling Accuracy Analysis

Sampling accuracy was calculated for each forest type to ensure that sufficient samples had been taken to provide estimates within acceptable limits of error.

Using variable plot sampling, the basal area per acre was directly proportional to the number of trees per plot. Thus a reliable measure of sampling error was obtained by calculating the standard error of the number of trees per plot within a particular forest type. If the sampling error was not within acceptable limits then additional sample plots were taken. A sampling error of $\pm$ 10 percent with probability of 95 percent was considered as the largest acceptable for the productive forest types.

The following is an explanation of the terms and operations involved in the calculation of the sampling error for a particular forest type.

(1) A forest type is considered as the sampled population.

(2) "n" is the number of plots within the forest type, that is, the number of tally cards, including the empty plots with no trees tallied.

(3) "x" is the number of trees tallied in any plot $\frac{n}{M}$ (x) is the sum of number of trees tallied in "n" plots.

(4) $\frac{}{x}$ is $\frac{\frac{n}{M}(x)}{n}$ or (3) divided by (2), is the Mean Sample, it is referred to as "x bar".

(5) $\frac{n}{M}$ (x^2) is the sum of squares of the number of trees in "n" samples.

(6) $\frac{}{x}\frac{n}{M}$ (x), or (4) multiplied by (3) is the mean sample multiplied by the sum of number of trees, tallied in the forest type.

(7) SSR is $\frac{n}{M}(x^2) - \bar{x}\frac{n}{M}(x)$, or (5) minus (6) is the sum of squares of Residuals.

(8) $MSR = \frac{SSR}{n-1}$ or (7) divided by (2) less one, is the mean square, or the Variance.

(9) SD is $\sqrt{MSR}$ or $\sqrt{(8)}$ is Standard Deviation.

(10) CV is $\frac{SD}{x}(100)$ or $\frac{(9)}{(4)}(100)$ is Coefficient of variation expressed in percent. It is the ratio of the Standard Deviation to the Mean Sample.

(11) SE is $\frac{CV}{\sqrt{n}}$ or $\frac{(10)}{\sqrt{(2)}}$, is the Sampling Error (or Standard Error) of the estimate, expressed in percent.

6.2.1.1 Procedure

The calculation of Sampling Error is simplified by the use of a Sharp electronic calculator. Model 32 or Model 361, that is a model with two memories, instant square and instant square root. The Sampling Accuracy Analysis form was used. The headings of the columns of the form indicate the consecutive mathematical operations.

The procedure is as follows. All tally cards belonging to the studied forest type are sorted out and counted. The number of plots, which in most cases coincide with the number of tally cards, including any empty ones, is entered into the form under the heading (2). Square root of that number is obtained and entered in the form. Number of trees on each tally card is punched, stored in Memory I, squared and stored in Memory II. This is repeated until the last tally card is used. Then the accumulated sum from the Memory I is recalled and entered in the form under heading (3); the sum accumulated in Memory II is entered under heading (5). The rest is self explanatory. The versatility of the calculator and a thrifty use of its memories produce the final results in a matter of minutes.

6.2.2 Construction of Local Volume Tables

6.2.2.1 Calculation of Volumes of Sample Trees

Volumes of felled and bucked trees outside and inside bark and volumes of respective defect are calculated using Smalian's formula:

$$V = (Ab + At)\ 0.50\ h$$

Where V is the volume in true cubic feet.

Ab is the crossectional area in square feet at the thicker end of the log.

At is the crossectional area in square feet at the thinner end of the log.

h is the length of the log, in feet.

Table 6.2a gives the crossectional areas in square feet for diameters in one inch classes.

The volumes are calculated and entered on the Volume and Defect Study form.

6.2.3 Regression Analysis

Constructing volume tables have been used which are applicable to tropical hardwood forest stands for estimating volume of merchantable bole in the true cubic feet.

The choice of a regression equation for determining of the relationship between volume, diameter and height was subject to the following limitations and assumptions.

The regression equation cannot produce negative volumes.

Therefore, the regression line must go through the point of origin of the graph.

Form No. 1

Forest Inventory - Sampling Accuracy Analysis Form

①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	⑪
FOREST TYPE	n	$\sum_{M}^{n}(x)$	$\bar{x}$, ③/②	$\sum_{M}^{n}(x^2)$	③.④	⑤-⑥	⑦/②-①	$\sqrt{⑧}$	⑨/④. 100	⑩/ $\sqrt{②}$

Table 6.2a—Cross-Sectional Areas

Diameter Inches	Area Sq. Feet	Diameter Inches	Area Sq. Feet	Diameter Inches	Area Sq. Feet
3″	.05	36″	7.07	66″	23.76
4″	.09	37″	7.47	67″	24.48
5″	.14	38″	7.88	68″	25.22
		39″	8.30	69″	25.97
6″	.20	40″	8.73	70″	26.72
7″	.27				
8″	.35	41″	9.17	71″	27.49
9″	.44	42″	9.62	72″	28.27
10″	.54	43″	10.08	73″	29.06
		44″	10.56	74″	29.87
11″	.66	45″	11.04	75″	30.68
12″	.78				
13″	.92	46″	11.54	76″	31.50
14″	1.07	47″	12.05	77″	32.34
15″	1.23	48″	12.57	78″	33.18
		49″	13.10	79″	34.04
16″	1.40	50″	13.64	80″	34.91
17″	1.58				
18″	1.77	51″	14.19	81″	35.78
19″	1.97	52″	14.75	82″	36.67
20″	2.18	53″	15.32	83″	37.57
		54″	15.90	84″	38.48
21″	2.40	55″	16.50	85″	39.40
22″	2.64				
23″	2.88	56″	17.10	86″	40.34
24″	3.14	57″	17.72	87″	41.28
25″	3.41	58″	18.35	88″	42.23
		59″	18.99	89″	43.20
26″	3.69	60″	19.64	90″	44.18
27″	3.98				
28″	4.28	61″	20.30	91″	45.16
29″	4.59	62″	20.97	92″	46.16
30″	4.91	63″	21.65	93″	47.17
		64″	22.34	94″	48.19
31″	5.24	65″	23.04	95″	49.22
32″	5.58				
33″	5.94			96″	50.26
34″	6.30			97″	51.31
35″	6.68			98″	52.38
				99″	53.45
				100″	54.54

Form No. 2

Project No. .....

Regression Analysis

Species .....

Samples

Diameter inches	*r square*	*Y volume* cubic feet

NOTE: $Y = r\text{ sq. } m$

$m = \dfrac{\text{Sum y}}{\text{Sum r sq.}}$

It was assumed that the relationship of volume to diameter is non-linear, and that the variance of volume about the regression line is not homogeneous.

The following regression equation was used:

$$Y = r^2m$$

Where Y is volume in true cubic feet, inside bark, r is a radius of crossection at dbh, or half diameter,

m is regression coefficient, incorporating height and form factors.

The regression coefficient was obtained from the measured sample trees by the ratio solution, that is by dividing the sum of compiled volumes, (inside bark), by the sum of corresponding squared radii.

For the purpose of these calculations, the sample trees were assembled by species. The assemblies of species with near-identical coefficients were grouped together. Their mutual coefficient was recompiled and they formed a group volume table.

The value of regression coefficient reflects height and form factor of the group. For practical application there are significant differences between two proximate volume tables. On the other hand the tables pass a test of precision.

6.2.3.1 Test of Precision

Aggregate deviation are calculated by substituting volume table values for the values of measured sample trees. Aggregate deviation, which indicates, freedom from bias in volume tables are less than plus or minus one per cent. Six different volume tables are used.

The non-linear function $y = r^2m$ has been fitted as a linear on a model (graph) in which the diameters on the X axis are transformed to the corresponding r^2 values, that is to the half-diameter squared.

Regression Analysis forms were used to control the calculations of the regression coefficients.

6.2.3.2 Explanation of the Regression Equation $y=r^2m$

Merchantable bole of a tree with little taper may be analysed as a cylinder. Volume of a cylinder may be expressed as a product of Basal Area and Height. Basal Area may be expressed as r^2, or $3.14\ r^2$, hence the volume may be expressed as $3.14r^2$ height.

The "r" or half diameter of the tree is measured in inches, the height of tree is measured in feet. To obtain the volume expressed in cubic feet, therefore, the above volume equation must be divided by 144.

$$\text{Volume} = \frac{3.14\ r^2\ \text{height}}{144}$$

The height of merchantable bole in the tropics often oscillates around 46 feet. In such a case.

$$\text{Volume} = \frac{3.14\ r^2 \times 46}{144} = r^2$$

The classical equation therefore is: volume $= r^2$. However, the merchantable bole may be higher or lower than 46 feet, and also taper of the bole, or the form of the tree must be taken under consideration. To compensate for height and taper the volume equation takes the final form:

$$\text{Volume} = r^2m$$

where "m" is the regression coefficient.

For the final volume tables weighted average height were compiled for every species or species group. The heights of sampled trees (clear bole), were weighted by their volumes. The regression coefficient "m" was divided by the weighted average height, a new regression coefficient was obtained in this manner and a new regression equation: Volume $= nR^2h$. Using this equation, tables by height classes were constructed for species or species groups as warranted by sufficient data.

6.2.4 **Stand Table Compilation**

The following are procedures for constructing stand tables based on variable plot sampling method with an instrument calibrated to a factor of 20 square feet of basal area per acre.

6.2.4.1 Preparation

Select tally cards for all sample plots taken within the particular forest type and count all plots including the empty ones.

Transfer every tallied tree by a dot to Stand and Stock Table Compilation sheets, by species and by one inch diameter classes.

Count the dots in every square and enter the figure in the square. Count all trees transferred and check the number against the total of trees tallied in type to eliminate any errors.

Prepare Stand Table sheets with species listed in alphabetical order, with columns for one inch diameter classes.

Count the dots in every square and enter the figure in the square. Count all trees transferred and check the number against the total of trees tallied in type to eliminate any errors.

Prepare Stand Table sheets with species listed in alphabetical order, with columns for one inch diameter classes from 6″ to 70″.

A table has been prepared, entitled Stand Table Factor for BAF 20—Table gives a general factor of a number of trees per acre corresponding every tree tallied, by one inch diameter classes, from 6″ to 70″ inclusive. The table is compiled by dividing the Basal Area Factor, that is 20, by the basal area in square feet corresponding every diameter class.

6.2.4.2 Calculation

To obtain number of trees per acre, the number of tallied trees for any species in any particular diameter class is multiplied by the corresponding stand table factor and divided by the number of plots taken in the studied forest type.

Use electronic computer with two memories. Enter the number of plots in type into Memory II. This memory is equipped with a key which simplifies repetitive division. From a stand table compilation sheet select a species in alphabetical order, punch the number of trees tallied in the lowest diameter class, multiply it by a corresponding factor from the table, divide it by Memory II. Enter the result into proper column in stand table, and accumulate it in memory I. Continue in this manner with the next diameter class. After finishing with the species, recall memory I and enter the accumulated sum in the stand table as the total number of trees for the particular species. Clear Memory I and proceed with the next species.

After completing the calculations, columns and lines are summarized to cross check, and percentages are calculated by species and by diameter classes.

6.2.5 Construction of Stock Tables

Stock tables are compiled by multiplying the number of trees per acre, as in the stand table, by the appropriate volume per tree from the Volume Tables. Only trees in diameter classes 12″ to 70″ inclusive will be represented in the Stock Tables. Crosscheck of columns and lines is carried out and percentages are calculated by species and by diameter classes.

6.2.6 Data Analysis

Tables by species in alphabetical order and by one inch diameter classes are cumbersome, therefore, summaries have been prepared for presentation and for further analysis.

6.2.6.1 Species

Species in the summaries are listed in the order of volume, the species with the highest volume first.

The Meranti are grouped into Red Meranti, Yellow Meranti and White Meranti, using as basis Foresters' Manual of Dipterocarps by C. F. Symington, Malayan Forest Records No. 16. All Keruings are also grouped together under one heading.

Separate summaries are prepared to show the volume distribution among the various species of Red Meranti and of Keruing.

Nemesu (Shorea Curtisii), also Seraya (Shorea Curtisii) are treated as individual species and not summarized under Red Meranti.

Form No. 3—Forest Inventory—Stand and Stock Table Compilation

Forest Type:.....

Species					6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70

Species					6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70

Table 6.2b—Stand Table Factor for BAF 20

Diameter Inches	General Factor	Diameter Inches	General Factor
6	100.000	36	2.829
7	74.074	37	2.677
8	57.143	38	2.538
9	45.455	39	2.409
10	37.037	40	2.290
11	30.303	41	2.181
12	25.641	42	2.079
13	21.739	43	1.984
14	18.692	44	1.893
15	16.260	45	1.811
16	14.286	46	1,733
17	12.658	47	1.659
18	11.299	48	1.591
19	10.152	49	1.526
20	9.174	50	1.466
21	8.333	51	1.409
22	7.576	52	1.355
23	6.944	53	1.305
24	6.369	54	1.258
25	5.865	55	1.212
26	5.420	56	1.169
27	5.025	57	1.129
28	4.673	58	1.089
29	4.357	59	1.053
30	4.073	60	1.018
31	3.817	61	0.985
32	3.584	62	0.954
33	3.367	63	0.924
34	3.175	64	0 895
35	2.994	65	0 868
		66	0.842
		67	0.817
		68	0.793
		69	0.770
		70	0.749

Different Balau are summarized together, as well as any lesser species tallied under the same local name followed by a different epithet. The main species, that is the first five species contributing to the highest volume are sub-totalled, and the types distinguished from one another by the order of these five main species. Other species follow in the summary under the heading of "Minor Species" in descending order of volume, disregarding any species contributing less than 1% of volume per acre.

6.2.6.2 Diameter Classes

Columns with diameter classes are headed 12″-20″; 24″-36″; 40″-68″ and Total. In the class 12″ to 20″ one inch classes from 12 to 22 inches inclusive are summarized, in the class 24″-36″ are summarized one inch classes from 23″ to 38″ inclusive and in the class 40″-68″ are summarized all one inch classes beginning with the 39″ class and larger.

6.2.7 **Areas Calculation**

The base maps with the photo-interpretation detail transferred from the aerial photographs form the forest cover maps.

After the transfer, the types were checked for closure and labelled. The types are numbered in a consecutive order, grouped and listed. The areas of the individual types are measured with planimeter, summarized and the sum is checked against the overall area of the map sheet. Any discrepancy is corrected by prorating the difference to all forest types.

6.3 GUIDE TO PHOTO-INTERPRETATION

The purpose of the photo-interpretation is to sub-divide on the aerial photographs the heterogeneous forest stand into sub-units called strata or types, of more uniform characteristics, so that there would be more variation between types than within them, to obtain a more precise estimate of the forest stand.

The forest stand may look under a stereoscope at first sight completely intractable and it may seem very difficult to make any divisions within the stand. However, even an imperfect classification is better than the aggregation of unlike vegetation communities. The boundaries between the plant communities may be sharp, where sudden changes in site condition occur, or diffuse, where the changes are more gradual.

The differences in the structure of the forest stand result from many factors like climate, elevation, ground configuration, slope aspect, soil type, soil depth, drainage pattern, drainage quality, to mention the more obvious ones.

Observations of the conditions prevailing in the Pahang Tenggara study area show that the physiographic characteristics and drainage quality seem to have quite pronounced relationship with the existing forest strata.

6.3.1 Diagram

The diagram shows very schematically the relation of the physiographic features to the types. It is emphasized that the diagram should be treated only as a guide, especially since it was developed at an early stage of the survey. It is suspected that the diagram does not allocate all the types that will be eventually encountered in the studied area.

6.3.2 Code

The code is an adaptation of the code developed in the Forest Research Institute in Kepong. The changes, all of minor nature, were introduced to simplify both coding and decoding.

More importance is attached to the physiographic differences and the code describing them has been enlarged.

The size of the crowns seems to be the next most tangible characteristic visible on the photographs, and in conjunction with the physiographic characteristics may be indicative of different forest types. Four different crown sizes are distinguished and numbers from 1 to 4 are alloted to them, UBC crown width scale is used to compare the crown sizes.

Next after crown size comes the consideration of the canopy, its uniformity in height and closure.

Letters a, b and d are allotted to code the different aspects of the canopy.

The tone of the foliage of the crowns would have been of a great assistance if the photography was taken on infra-red film. The existing panchromatic film and substandard prints are of little help, except in the case of Seraya, for which the letter g has been retained.

The code includes also some international symbols to indicate man caused changes in the forest stand.

The code should be simple and flexible. It is recognized that some additional symbols may be developed during the progress of work, also that some symbols may be found confusing or redundant and as a result may be abandoned.

6.3.2.1 Physiographic Symbols

M = Mountain forest, above 3,500 ft. a.s.l.
R = Ridge, edaphic forest, non productive
P = High plateau

H = Hill, ridge, productive forest
HS = Hill, slope
D = Hill, dissected

U = Lowland, undulating
F = Lowland, flat
Rv = Riverine, near river, may be wet
S = Swamp, permanent, fresh water
T = Swamp, tidal, salt water
C = Coastal sand belt

6.3.2.2 Crown Size

1 — very small, smaller than No. 1 *on the UBC CROWN WIDTH SCALE*
2 — small, between No. 1 and No. 2 *on the UBC CROWN WIDTH SCALE*
3 — medium, between No. 2 and No. 3 *on the UBC CROWN WIDTH SCALE*
4 — large, larger than No. 3 *on the UBC CROWN WIDTH SCALE*

6.3.2.3 Canopy—Uniformity in Height and Closure

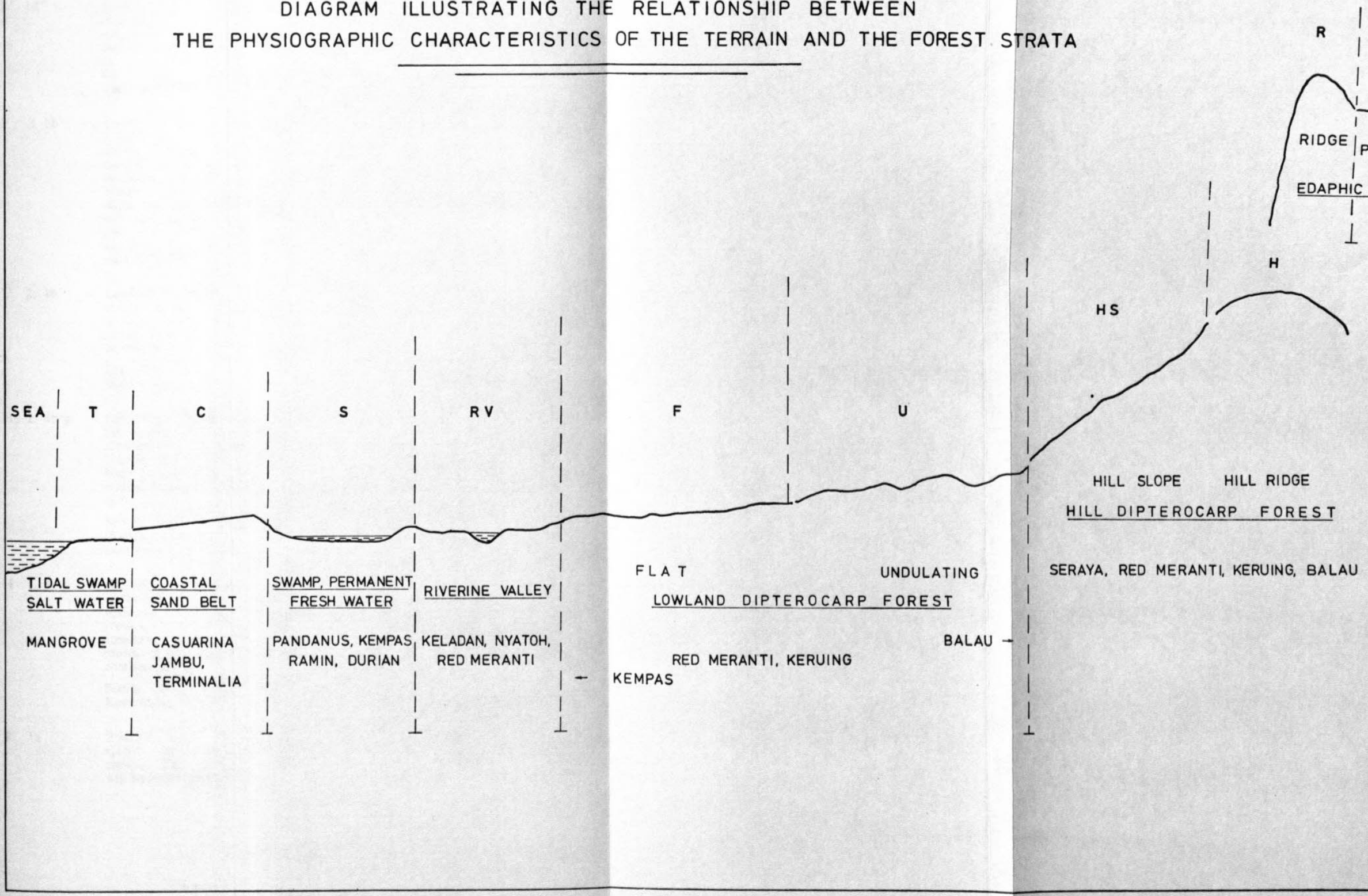
a — uniform height, closed canopy
b — broken height, closed canopy
d — broken height, open canopy or scattered trees
o — (above a, b or d)—prominent emergents
g — grey tone indicating Seraya
* — palms in natural forest stand
$\overline{x}$ — scrub and belukar

6.3.2.4 Man Caused Changes

Λ — Disturbed vegetation (upside down V)
Θ — Logged
Θ̊ — Selectively logged
Ⓓ — Burned
⊕ — Logged and burned, cleared
N̄ — Non forest
C — Cultivation
$\overline{C}$ — Shifting cultivation
¢ — Plantation, rubber, palm, orchard
O — Open, grassland
r — Erosion

Fig. 6.3

DIAGRAM ILLUSTRATING THE RELATIONSHIP BETWEEN THE PHYSIOGRAPHIC CHARACTERISTICS OF THE TERRAIN AND THE FOREST STRATA



6.3.2.5 Example of the Use of Symbols for Labelling of Interpreted Photographs

S 1d° — Swamp Forest, with scattered trees of very small crowns, with emergents. The field sampling may show this as non productive or as a marginal type e.g. Nyatoh, Red Meranti, Kedondong, Kelat, Kempas.

F 2, 3b° — Lowland Dipterocarp Forest on a flat ground, small to medium crowns, uneven height, closed canopy with emergents. It will be some combination of: Red Meranti, Keruing (Kedondong, Kelat, Kempas). This could also be a waterlogged, marginal forest type with some Meranti paya, but the code in such case would read F 1, 2b°.

U 2, 4b° — Lowland Dipterocarp Forest, on undulating ground, with small to large crowns, uneven height, closed canopy with emergents. It will be a combination of:

Red Meranti, Keruing, Balau (Kedondong, Kelat).

HS 2, 4b°g — Hill Dipterocarp Forest, on the slopes, with small to large crowns, of uneven height, closed canopy with emergents, with a large proportion of grey tone crowns. It will be a combination of:

Seraya, Keruing, Red Meranti (Kedondong and may be Rengas) with occasional Balau.

H 1, 3a°g — Hill Dipterocarp Forest, on top of the hill or on the low ridges, with very small to medium crowns, of uniform height with emergents and predominant crowns of grey tone. It will be a combination of:

Seraya, Red Meranti (Kelat, Kedondong, Rengas).

R 1a — Edaphic forest on the high ridges with small uniform crowns. The type presumably will be *NON* productive.

The above are presented only as examples of coding and suggested assumptions that might be derived. Field data supplies the details with reference to the characteristics of the humidity of the soil (infra red photographs would allow detection of waterlogged conditions) and of Species Composition and Volumes. Crown size 1″ with characteristics "a" may also be encountered in a second growth forest.

The differences between the types outlined on the aerial photographs must be significant. It has to be kept in mind that it is easier to distinguish between the types on the photographs than on the ground, and that the types on the aerial photographs must be recognizable on the ground.

6.4 FIELD CREW, ORGANIZATION

6.4.1 **Field Crew**

Nine men are required to form an efficient crew to carry out sampling and volume and defect study.

The position of each member and his duties are as follows:

1. Cruiser is in charge of the crew. He is trained in the use of relascope, keeps tally cards and other notes.
2. Compassman. His job is to mark out a line through the forest on the compass bearing given to him by the cruiser. Silva Ranger Compass, 360 degrees with correction for declination will be used. Cruiser presents the compass to the desired angle. Compassman leads the cruise and cuts a path wide enough to proceed.
3. & 4. Two cutters. They follow compassman closely and help to clear and widen the path, otherwise they assist where necessary in clearing paths to the sighted trees at the sampling plots.
5. Head Chain Man. He goes behind the compassman and cutters, and at a predetermined distance places a stick face high, as a centre of the plot. On the plot he measures diameters of the trees pointed out by the cruiser, when accessible.
6. Rear Chainman holds the tail end of the chain and measures distances between plot centres, and together with Head Chainman measures distances from the plot centre to the centre of any doubtful tree, applying slope correction when required, and assists in measuring tree diameters.

7. Tree Indentifier, seconded to the Study by Malaysian Forest Service identifies trees pointed out by the cruiser.

8. Power Saw Man. Fells and bucks trees marked for the volume and defect study.

9. Power Saw Helper. Helps the power saw man, sharpens the chain-saw, carries fuel, axe, wedges and collects wood samples.

6.5 SAMPLING PROCEDURE

6.5.1 **Recapitulation**

The strip was a day's assignment for one surveying crew. The crew consisted of a Cruiser and eight assistants. Their daily output averaged 20 plots tallied. Trees on one or two plots were felled and measured. The plots were spaced at 400 feet and the crew covered during the productive day's work approximately one mile and a half.

6.5.2 **Procedure**

The Cruiser was given an instruction sheet and aerial photographs necessary for each day's work. The instructions contained the following:

— forest block
— strip number
— photo number
— point of commencement
— bearing of strip
— any special instructions if required
— date of assignment

Fieldwork was conducted as follows:

6.5.2.1 Establishment of Point of Commencement

Point of commencement marked on the photograph is located on the ground and marked on a nearest tree in a conventional manner. Information on a blaze will include strip number, bearing, date.

6.5.2.2 Starting Line

With the proper bearing on the dial of the compass, the compassman stands at the p. of c. and takes the first compass site, then the compassman travels through the forest on the bearing, cutting the trail.

6.5.2.3 Chaining

The front chainman takes the zero end of the chain and walks down the cut line. Rear chainman stops the front chainman by calling chain when the full chain (200 feet) has run out. The rear chainman sights clinometer on the front chainman and reads the slope correction in percent, finds the correction from table, measures it and calls to front chainman "pull tight". Front chairman makes mark with sticking barked stick in the ground at the zero mark.

6.5.2.4 Plot Centre

When the position of the plot centre is marked the front chainman cuts a stick some three inches thick and 5 feet long, sharpens both ends and sticks it solidly in the mark. Number of plot is marked on the stick to help checking and control of the survey.

6.5.2.5 Organization of Tally

The chain is pulled a short distance beyond the centre on the same bearing and dropped.

The cruiser should be able to use both eyes simultaneously, with one eye observing the tree, with another checking the scale.

Trees that appear in the relascope as larger (wider) than the appropriate basal area scale are tallied. Trees that appear in the relascope as smaller than the appropriate scale are not tallied.

6.5.2.6 Doubtful Trees

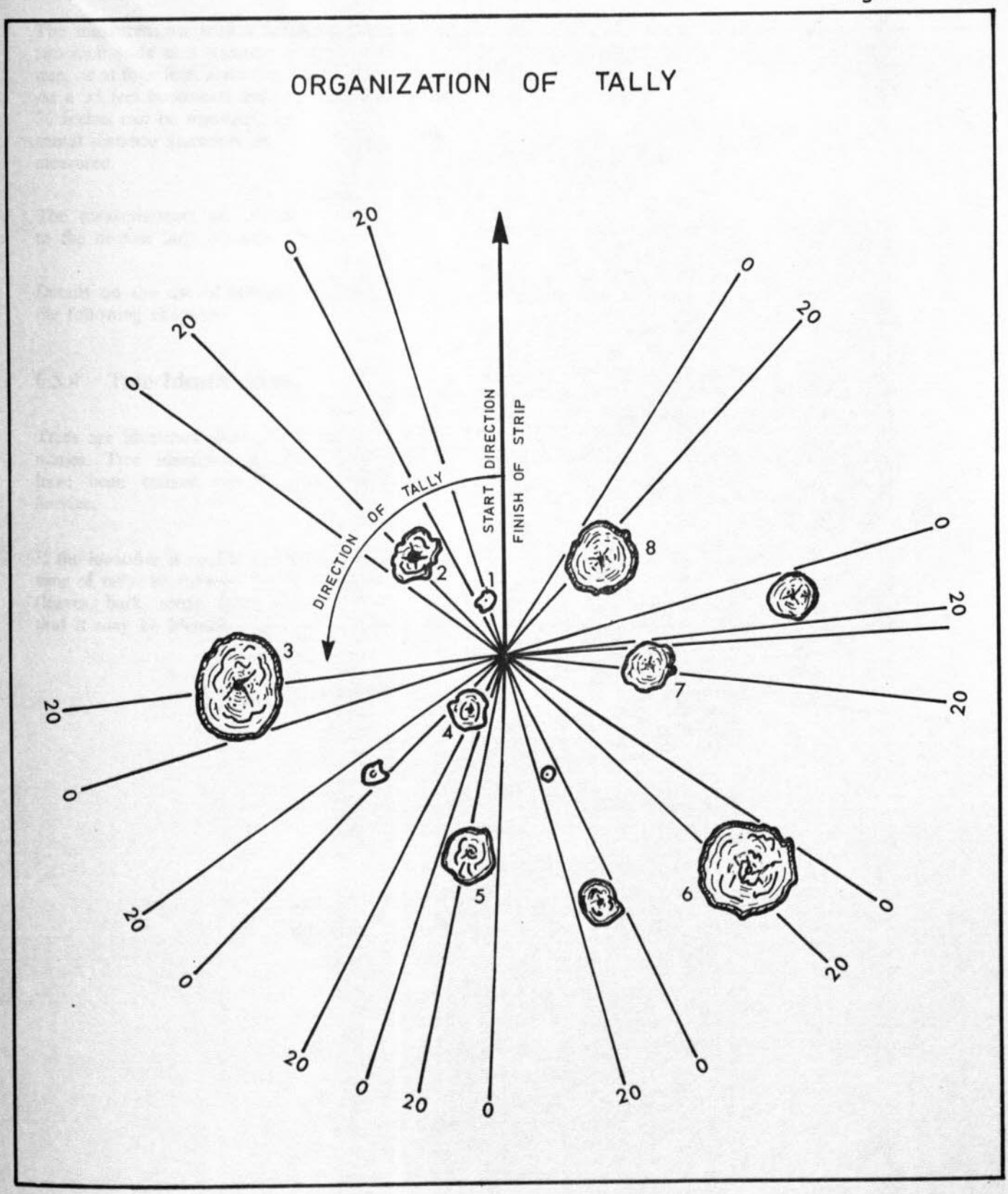
When it is difficult to decide if a tree is to be tallied because it is obsured from view, or because it is a borderline tree, the horizontal distance from the centre of the tree to the centre of the plot is measured.

The plot radius, that is the maximum distance for each diameter is given in a table. If the distance measured is shorter or equal to that in the table for the corresponding diameter, the tree is tallied—if the distance is larger the tree is not tallied.

6.5.3 **Tree Measurement**

The tree species is identified, recorded and the diameter breast height is measured with a diameter tape. When the use of diameter tape is not possible because of high buttressing or other obstruction, relascope is used to measure the diameter two feet above the obstruction.

Fig. 6.5


ORGANIZATION OF TALLY
DIRECTION OF TALLY
START DIRECTION
FINISH OF STRIP
1
2
3
4
5
6
7
8
0
20

The measurements with a relascope are read at two inch scale at a distance of 33 feet from the tree, or at four inch scale at a distance of 66 feet. At a 33 feet horizontal distance diameters up to 36 inches can be measured, and at 66 feet horizontal distance diameters up to 72 inches can be measured.

The measurements are estimated (interpolated) to the nearest inch diameter class.

Details on the use of relascope are included in the following chapters.

6.5.4 **Tree Identification**

Trees are identified and recorded by their local names. Tree identifiers assigned to the Study have been trained by the Malaysian Forest Service.

If the identifier is unable to identify a tree at the time of tally, he collected the necessary materials (leaves, bark, seeds, flowers) from the tree, so that it may be identified later.

Each unidentified tree is tallied as unknown. The collected sample is marked with the number of strip and number of plot, so that when the tree has been identified, the proper name could be substituted in the tally card.

6.6 VOLUME AND DEFECT STUDY

The trees in the first and/or second sample plot were felled and measured. The trees in these plots were marked with coloured tape. As soon as the first plot was tallied, men with power saws set to work. Marked trees were felled and bucked at 16 feet measuring from the stump, at 32 feet and under the branches or at 10 inch diameter which ever occurred first. When the cruiser returned after finishing the strip, the felling and bucking were finished. The cruiser made notes of the bottom and top diameters of every log, inside and outside bark, of the diameters and length of any defect, keeping a separate record for every tree. These notes were kept separately from the tree tallies. In the case of defect, more bucking was required to determine exact measurements at both ends of the affected portion of the log.

All diameter measurements for this study are taken to the nearest tenth of an inch. The length measurements will be taken to the nearest foot.

Table 6.5—Plot Radius in Feet From Plot Centre to Tree Centre
Basal Area Factor 20

Tree Diameter (Inches)	Plot Radius (Feet)	Tree Diameter (Inches)	Plot Radius (Feet)	Tree Diameter (Inches)	Plot Radius (Feet)
4.0	7.8	25.0	48.6	62.0	120.6
4.5	8.8	26.0	50.6	63.0	122.5
5.0	9.7	27.0	52.5	64.0	124.4
5.5	10.7	28.0	54.4	65.0	126.4
6.0	11.7	29.0	56.4	66.0	128.3
6.5	12.6	30.0	58.3	67.0	130.3
7.0	13.6	31.0	60.3	68.0	132.2
7.5	15.0	32.0	62.2	69.0	134.2
8.0	15.6	33.0	64.2	70.0	136.1
8.5	16.5	34.0	66.1	71.0	138.1
9.0	17.5	35.0	68.1	72.0	140.0
9.5	18.5	36.0	70.0	73.0	142.0
10.0	19.4	37.0	72.0	74.0	143.9
10.5	20.4	38.0	73.9	75.0	145.8
11.0	21.4	39.0	75.8	76.0	147.8
11.5	22.4	40.0	77.8	77.0	149.7
12.0	23.3	41.0	79.7	78.0	151.7
12.5	24.3	42.0	81.7	79.0	153.6
13.0	25.3	43.0	83.6	80.0	155.6
13.5	26.2	44.0	85.6	81.0	157.5
14.0	27.2	45.0	87.5	82.0	159.4
14.5	28.2	46.0	89.4	83.0	161.4
15.0	29.2	47.0	91.4	84.0	163.3
15.5	30.1	48.0	93.3	85.0	165.3
16.0	31.1	49.0	95.3	86.0	167.2
16.5	32.1	50.0	97.2	87.0	169.2
17.0	33.1	51.0	99.2	88.0	171.1
17.5	34.0	52.0	101.1	89.0	173.1
18.0	35.0	53.0	103.1	90.0	175.0
18.5	36.0	54.0	105.0	91.0	177.0
19.0	37.0	55.0	107.0	92.0	178.9
19.5	37.9	56.0	108.9	93.0	180.8
20.0	38.9	57.0	110.8	94.0	182.8
21.0	40.8	58.0	112.8	95.0	184.7
22.0	42.8	59.0	114.7	96.0	186.7
23.0	44.7	60.0	116.7	97.0	188.6
24.0	46.7	61.0	118.6	98.0	190.6
				99.0	192.5
				100.0	194.4

Form No. 4—Forest Inventory—Field Sampling Card

Day..... Month..... Year..... Block..... Strip No..... Plot No.....

Sh. No..... Distance from P. of C..... Bearing Degrees.....

Photo No..... Flight Line..... Cruiser.....

B A F 20 Strata Code VIRGIN LOGGED SECONDARY

Tree No.	Species	D.B.H. (IN.)
	Stump Form	Stem Form
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		

COMMENTS

Stump Form 1 2 3 4

Stem Form 1 2 3 4

SITE FEATURES

Aspect ..... Slope % .....

Soil Description:

Soil Depth:

Moisture: Dry ..... Medium ..... Wet ..... Very Wet .....

FOREST COVER

Emergents....., Upper and Lower Storey....., One Storey.....

Crown closure: Open 1, closed 2, ..., ...

Defect Description:

Damage:

UNDERGROWTH Sparse ..... Medium ..... Dense ..... Very Dense .....

Shrub....., Palm....., Bamboo....., Climbers....., Herbs....., Grass.....

REGENERATION Sparse ..... Medium ..... Dense ..... Very Dense .....

Predominant Species

1. 2. 3. 4.

Plot centre (6 ft. radius × 800 = 1 ha)

Species	No.	Notes
1.		
2.		
3.		
4.		
5.		
6.		

Form No. 5—Forest Inventory—Volume and Defect Study

Strip No:..... Plot No:..... Tree No:.....

Species:

		Diameter (Inches)		Defect		Comments
		Outside Bark	Inside Bark	Diameter (Inches)	Length (Feet)	
Branch # 2	Top					
	Length Ft.					
	Bottom					
Branch # 1	Top					
	Length Ft.					
	Bottom					
	Top					
	(Feet) Length ___					
	32 Feet					
	16 Feet					
	Stump					

6.7 USE OF RELASCOPE

A mirror relascope is used for determining which trees are to be tallied and to measure diameter of unaccessible trees. All measurements are taken through the eyepiece of the relascope by holding the eyepiece as close as possible to one eye. The button releases the scale wheel which is calibrated to compensate for slope.

The procedures for taking the required measurements using an American Scale relascope are as follows. Procedures are based on using a basal area factor of 20 square feet per acre.

6.7.1 Tree Tally

While looking through the eyepiece the upper edge (measuring edge) of the scale is aligned along the tree at the breast height. The button is pressed to release the wheel scale and allow the scale to stop by itself. The "0" edge of the scale (Diagram 2) is lined along the edge of the tree being measured. Holding this position, the tree appears larger or smaller in width than the distance between the "0" edge and the "20" edge of the scale. If the tree width is between the "0" edge and the "20" edge the tree is not tallied. If the tree width is greater than the distance between the "0" edge and the "20" edge, the tree is tallied.

6.7.2 Tree Diameter

The six equal-width bars (3 white and 3 black) between scale edge "a" and scale edge "b" are used in measuring tree diameter. The diameters at various horizontal distances are given in the following table:

Horizontal Distance	Diameter from Edge "a" to "b" (3 white, 3 black bars)	Diameter per Bar
33 feet	1 foot	2 inches
66 feet	2 feet	4 inches

The scale distances between edges "0" and "10", as well as "10" and "a", are equal to the distance between edges "a" and "b". Therefore, it is possible to measure tree diameters up to three times as large as that of the diameter between scale "a" and "b". Maximum diameters measurable at given horizontal distances are as follows:

Horizontal Distance	Starting at Scale Edge "10"	Starting at Scale Edge "0"
33 feet	2 feet	3 feet
66 feet	4 feet	6 feet

Diameters may be taken at any height with no mathematical corrections for slope because the scale is self-adjusting.

To ensure a tree diameter, align the "a" scale edge (or the "0" scale edge or the "10" scale adge) with the left side of the tree and count the number of small bars covered by the tree (Diagram No. 3). The tree diameter is calculated by multiplying the number of small bars covered by the diameter represented by each bar. If scale edge "0" or "10" is used then the diameter to "a", or from "10" to "a", must be added to the value of the small bars.

Fig. 6.7a

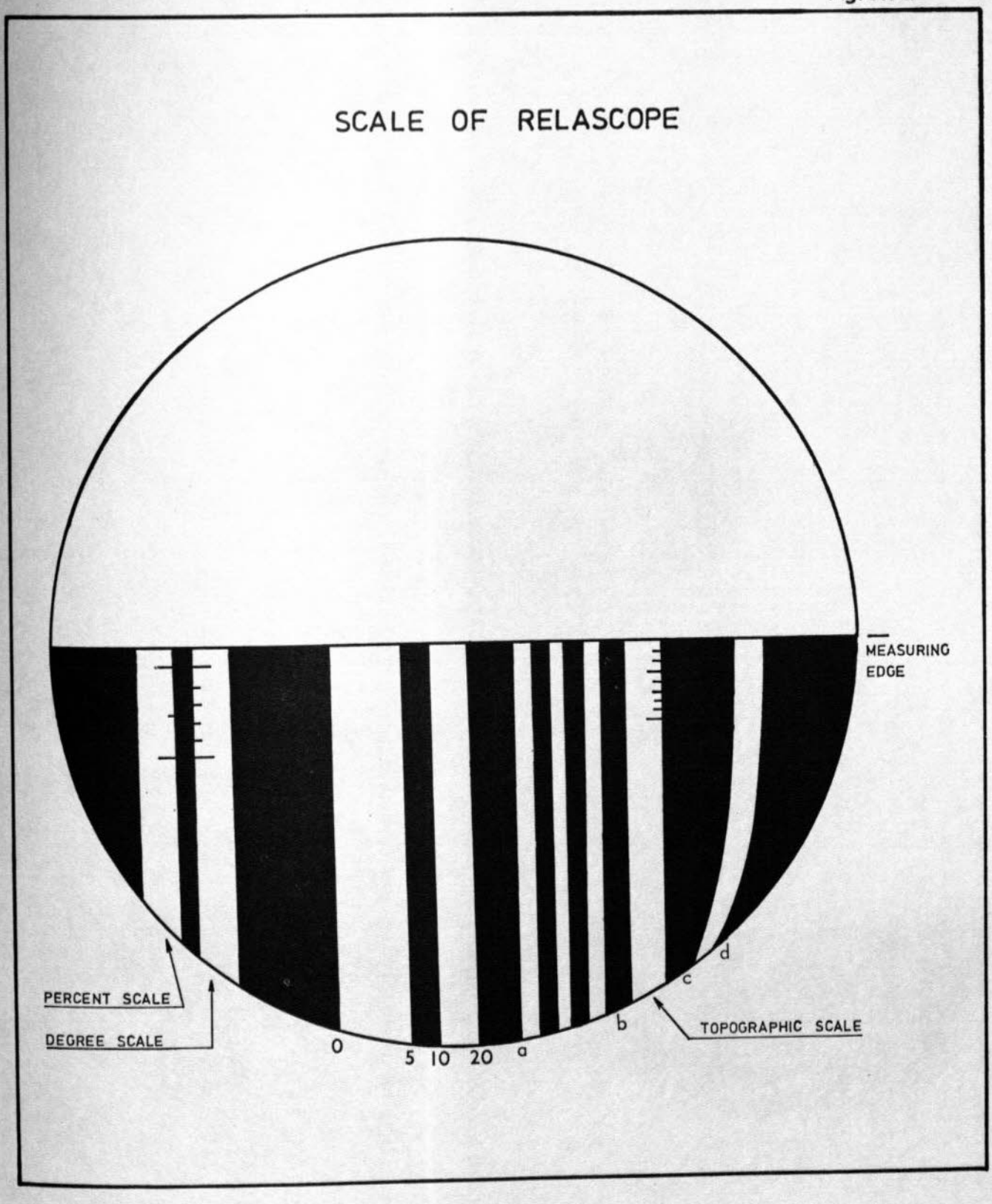
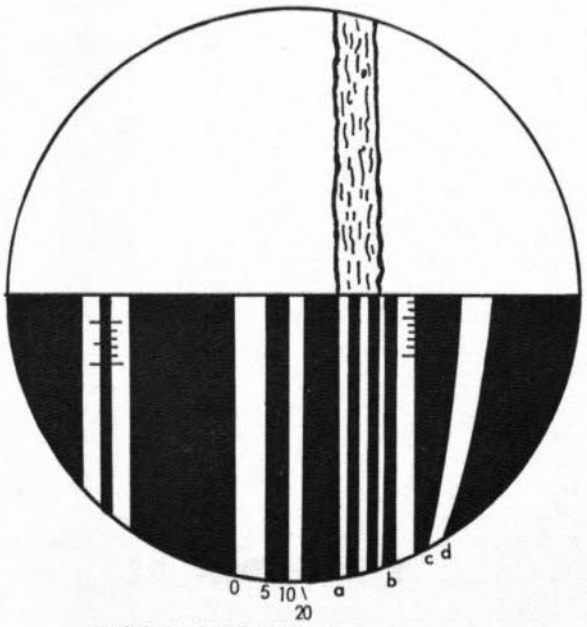
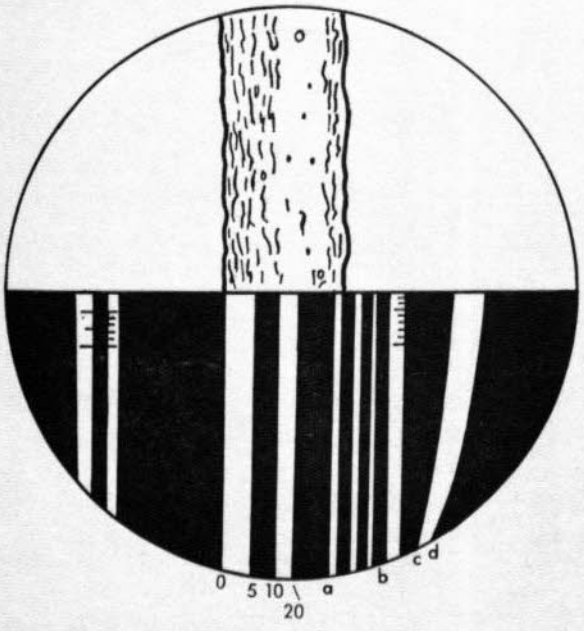

SCALE OF RELASCOPE
MEASURING EDGE
PERCENT SCALE
DEGREE SCALE
0
5
10
20
a
b
c
d
TOPOGRAPHIC SCALE

Fig. 6.7b

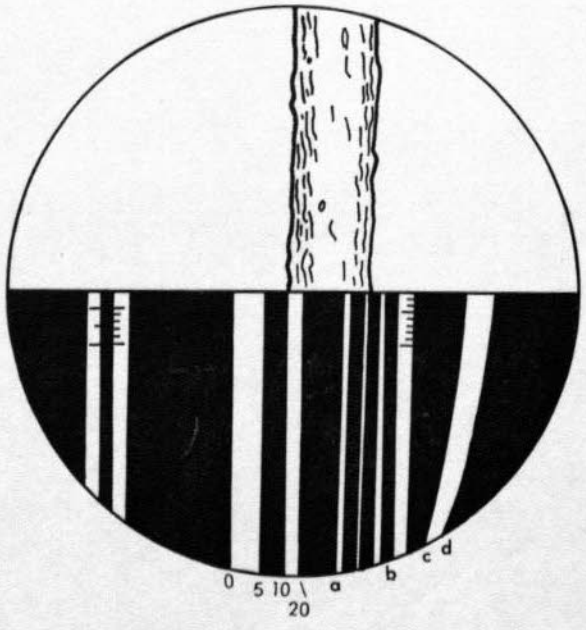
MEASURING OF TREE DIAMETERS



TREE ALIGNED WITH THE SCALE 'a'



TREE ALIGNED WITH THE SCALE '0'



TREE ALIGNED WITH THE SCALE '10'

7.0 APPENDIX B

7.0 BRIEF DESCRIPTION OF TREE SPECIES

Alphabetical list and description of species shown on the diagrams in paragraph 2.4.4 of the Report.

Balau.
Batai Hutan.
Bayur.
Bintangor.

Chengal.
Durian.
Geronggang.
Giam.
Jelutong.
Kadis.

Kapur.
Kasai.
Kedondong.
Keladan—*See* Kapur.
Kelat.
Kembang-Semangkok.
Kempas.
Keranji.
Keruing.
Kulim.

Machang.
Mata Ulat.
Medang.
Melunak.
Mempening.
Mempisang.
Mengkulang *See* Kembang-Semangkok.
Meranti Red.
Meranti Yellow.
Meranti White.

Merawan.
Merbatu.
Merbau.
Mersawa.
Menyak Berok.
Nemesu.
Nyatoh.
Pauh Kijang.
Pelong.
Penarahan.

Perah.
Petai.
Petaling.

Ramin.
Rengas.
Resak.

Sepetir.
Seraya.

Tampoi.
Temponek.

Tulang Daing.

Balau, *Shorea spp.*, Dipterocarpaceae,

large trees of good form, abundant, air dry weight 55 lbs/cu. ft, hard, dark brown, used for heavy duty flooring, heavy construction.

Batai Hutan, *Albizzla spp.*, Leguminosae,

small to medium size trees, air dry weight 21 to 54 lbs/cu. ft, depending on species. Wood soft, sapwood white, heartwood dark, suitable for furniture, plywood, veneer.

Bayur Bukit, *Schoutenia accrescens*, Tiliaceae,

small to medium size tree, air dry weight 58 to 62 lbs/cu. ft, wood dark brown with streaks, moderately hard, strong and durable, used for general construction has potential as sliced veneer.

Bintangor, *Calophyllum spp.*, Guttiferae,

medium to large trees, air dry weight 35 to 45 lbs/cu. ft, soft, colour light straw, pinkish, used for core veneer, panelling, light construction.

Chengal, *Balanocarpus heimii*, Dipterocarpaceae,

large trees, locally abundant, air dry weight more than 55 lbs/cu. ft, hard and heavy, colour light, used for heavy construction.

Durian, *Durio spp.*, Bombacaceae,

medium to large trees, air dry weight 25 to 45 lbs, soft, colour light grey to yellowish brown, used as core veneer and light construction.

Geronggang, *Cratoxylon arborescens*, Hypericaceae,

medium size trees, air dry weight 35 lbs/cu. ft, soft, colour dark brown, used for plywood, furniture, joinery.

Giam, *Hopea nutans*, Dipterocarpaceae,

large trees of good form, air dry weight 59 lbs/cu. ft, colour dark brown, hard and strong used in heavy construction.

Jelutong, *Dyera costulata*, Apocynaceae,

large trees of good form, popular timber, air dry weight less than 35 lbs/cu. ft, soft, colour off white to yellow, used for plywood, molding, pattern making.

Kandis, *Garcinia griffithi*, Guttiferae,

small to medium size tree of good form, air dry weight 55 lbs/cu. ft, colour dark, wood hard, durable used as poles and in general construction.

Kapur, *Dryobalanops aromatica,* Dipterocarpaceae.

Keladan, *Dryobalanops oblongifolia,*

Kapur, a large tree of good form, locally abundant on well drained forest sites; keladan, a medium size tree typical to riverine forest type; air dry weight 45 to 55 lbs/cu. ft, moderately hard, colour dark, reddish brown. Suitable for veneer, flooring, furniture, general construction.

Kasai, *Pometia spp.,* Sapindaceae,

medium to large trees, air dry weight 45 to 55 lbs/cu. ft, hard, colour dark, suitable for veneer, flooring, general construction.

Kedondong, *Canarium spp., Dacryodes spp., Santiria spp.,* Burseraceae,

medium to large trees, buttressed, very abundant, air dry weight 35 to 45 lbs/cu. ft, colour brown, used for plywood and general construction.

Keladan—*See* Kapur.

Kelat, *Eugenia spp.,* Myrtaceae,

small to medium size trees, very abundant, air dry weight 45 to 55 lbs/cu. ft, hard, colour light, suitable as peeler, general construction, railway ties.

Kembang-Semangkok, *Scaphium spp.,* Sterculiaceae,

Mengkulang, *Heritiera spp., Tariettia spp.,*

medium size trees, air dry weight 35 to 45 lbs/cu. ft, soft to moderately hard, sapwood light colour, heartwood dark brown, often with streaks, used for plywood, panelling, furniture.

Kempas, *Koompasia malaccensis,* Leguminosae,

large, buttressed trees of good form, air dry weight from 45 to 55 lbs/cu. ft, moderately hard; sapwood yellowish, heartwood dark reddish-brown, has potential in veneer, flooring, heavy construction, railway ties if treated.

Keranji, *Dialium spp.,* Leguminosae,

medium size trees, air dry weight 55lbs/cu. ft, hard colour dark brown, very strong suitable for sliced veneer, panelling, flooring.

Keruing, *Dipterocarpus spp.,* Dipterocarpaceae,

at least five species of near identical timber properties, large trees of good form, air dry weight 45 to 55 lbs/cu. ft, moderately hard, dark brown, popular as timber for general construction, used in U.S.A. as peeler.

Kulim, *Scorodocarpus borneensis,* Olacaceae,

small to medium size tree, air dry weight 45 to 55 lbs, moderately hard to hard, colour dark reddish brown, used for general construction, has potential as sliced veneer.

Machang, *Mangifera spp.,* Anacardiaceae,

medium to large trees of good form, air dry weight 35 to 45 lbs/cu. ft, moderately hard, sapwood light colour, heartwood brown, used for veneer, plywood, furniture, cabinet work.

Mata Ulat, *Lophopetalum spp.,* Celastraceae,

medium to large trees of good form, air dry weight 35 to 45 lbs/cu. ft, soft, of light colour, used for veneer and light construction.

Medang, *several species* of Lauraceae family,

medium size trees, abundant, air dry weight 35 to 40 lbs/cu. ft, soft, of light colour, suitable for plywood, light construction.

Melunak, *Pentace spp.* Tiliaceae,

medium size tree, air dry weight 35 to 45 lbs/cu. ft, sapwood light colour, heartwood reddish brown, used for furniture, decorative panelling, potential for peeling, slicing.

Mempening, *Quercus spp.,* Fagaceae,

small to medium size trees, air dry weight 35 to 45 lbs/cu. ft, moderately hard, with coarse grain, dark brownish grey colour, used for general construction.

Mempisang, *Mezzettia spp.,* Annonaceae, *Monocarpia marginalis, Polyalthia spp.*

slender trees of good form, air dry weight from 33 lbs/cu. ft and up depending on species, wood soft to moderately hard, colour light, suitable for light construction, peeled and sliced veneer.

Mengkulang—*See* Kembang-Semangkok.

Meranti-Red

M. Kepong, *Shorea ovalis,* Dipterocarpaceae,
K. Langgong, *Sh. lepidota,*
M. Malantai, *Sh. macroptera,*
M. Rambai Daun, *Sh. acuminata,*
M. Sarang Punai, *Sh. parvifolia,*
M. Tembaga, *Sh. leprosula,*
and other;

large trees of good form very abundant, the most important group of general utility timbers, air dry weight from 35 to 45 lbs/cu. ft, wood soft, colour light brown to dark reddish-brown, used in plywood, furniture, joinery, cabinet making, panelling light construction.

Yellow Meranti:

Damar Hitam, *Shorea multiflora,* Dipterocarpaceae, and other *Shorea species,*

large trees of good form but often defective, air dry weight 35 to 45 lbs/cu. ft, soft, straw or off-white colour, used for plywood, furniture, joinery and light construction.

White Meranti:

Meranti Pa'ang, *Shorea bracteolota,* Dipterocarpaceae, and other *Shorea species,*

medium size trees of good form, air dry weight 35 to 45 lbs, soft, off-white colour, contains silica, used for plywood, light construction.

Merawan, *Hopea spp.* Dipterocarpaceae,

medium size trees, buttressed, air dry weight 35 to 45 lbs, moderately hard, coarse grain, colour dark brown, used for general construction.

Merbatu, *Parinari spp.*, Rosaceae.

medium size trees, air dry weight 35 to 45 lbs/cu. ft., moderately hard, colour light, used for general construction.

Merbau, *Intsia palembanica,* Leguminosae,

medium size trees, air dry weight 45 to 55 lbs/cu. ft, hard, dark brown with purple-black heart, suitable for decorative sliced veneer, panelling, flooring.

Mersawa, *Anisoptera spp.*, Dipterocarpaceae,

largest trees in the area, heavily buttressed, air dry weight 35 to 45 lbs/cu. ft, moderately hard, containing silica, colour light brown, used for veneer, plywood and general construction.

Minyak Berok, *Xantophyllum spp.*, Polygalaceae,

medium size trees, common, air dry weight 45 to 55 lbs/cu. ft, hard, colour light, used for general construction.

Nemesu, *Shorea pauciflora,* Dipterocarpaceae,

large trees of good form, well represented in the studied area, air dry weight 40 lbs/cu. ft, wood soft, colour reddish brown, used in plywood, furniture, panelling, light construction.

Nyatoh, *Palaquium and other species* of Sapotaceae family,

medium size to large trees, air dry weight 35 to 45 lbs/cu. ft, colour light brown to reddish brown, used in plywood, furniture, light construction.

Pauh Kijang, *Irvingia malayana,* Irvingiaceae,

large, buttressed tree, air dry weight 66 to 74 lbs/cu. ft, of light colour, hard, suitable for heavy construction, susceptible to termite attacks, should be treated.

Pelong, *Pentaspadon spp.*, Anacardiaceae,

medium size trees, air dry weight 45 to 55 lbs/cu. ft, of light colour, wood easy to work, not durable, used in general construction, suitable for core veneer.

Penarahan, *Knema spp.*, Myristicaceae, *Myristica spp.*, and other,

small to medium size trees, air dry weight 35 to 45 lbs/cu. ft, soft, pinkish or light red colour, used for veneer, plywood, furniture, light construction.

Perah, *Elateriospermum tapos,* Euphorbiaceae,

small to medium size trees, common, air dry weight 45 to 55 lbs/cu. ft, hard, coarse grain, sapwood light brown, heartwood dark brown, suitable for general construction.

Petai, *Parkia spp.*, Leguminosae,

small to medium size trees, air dry weight 35 to 45 lbs/cu. ft., of light colour, wood soft suitable for peeling.

Petaling, *Ochanostachys amentaceae,* Olacaceae,

small to medium size tree, air dry weight 45 to 55 lbs/cu. ft., moderately hard to hard, colour dark grey, used in general construction.

Ramin, *Gonystylus spp.*, Gonystylaceae,

medium size to large trees of good form, occurring on wet sites, air dry weight 35 to 45 lbs/cu. ft., colour white, wood soft to moderately hard, used for plywood.

Rengas, *Gluta spp., Melanorrhoea spp.*, Anacardiacese,

medium size trees of good form but containing skin irritant in bark and sap, air dry weight 45 to 55 lbs/cu. ft., moderately hard, sapwood white, heartwood dark red brown, suitable for decorative veneer, panelling, furniture.

Resak, *Vatica spp.*, Dipterocarpaceae,

small to medium size trees, air dry weight 55 lbs cu. ft., hard, light brown colour, used for heavy construction.

Sepetir, *Sindora spp.*, Leguminosae,

medium to large trees of very good cylindrical form with no buttressing, air dry 35 to 45 lbs/cu. ft., soft, works smoothly, sapwood yellowish, heartwood reddish brown with darker streaks, used as decorative veneer, panelling, furniture.

Seraya, *Shorea curtissi*, Dipterocarpaceae,

large trees of very good cylindrical form, occurring on hills on ridges and slopes, air dry weight 38 lbs/cu. ft., colour light red, soft, suitable for plywood, furniture, joinery, cabinet making, panelling, light construction.

Tampoi, *Baccaurea griffithi*, Euphorbiaceae,

small tree producing edible fruit, air dry weight 45 to 55 lbs/cu. ft., sapwood of light colour, heartwood dark, wood soft, suitable for sliced veneer.

Temponek, *Artocarpus rigidus*, Moraceae,

medium size to large tree, air dry weight 35 to 45 lbs/cu. ft., sapwood of light colour, heartwood dark, wood soft, suitable as core veneer.

Tulang Daing, *Milletia atropurpurea*, Leguminosae,

small tree occurring mostly in disturbed forest stands, air dry weight 35 to 45 lbs/cu. ft., wood moderately hard, of dark brown to purplish colour, suitable for sliced veneer, general construction.

8.0 APPENDIX C

8.0 INTENSIVE FOREST MANAGEMENT SYSTEM

8.1 INTRODUCTION

A revision of the approach to forest management and utilization is urgently required if the permanent forest estate is to be both defended and justified.

Malay Uniform System, successful as it may be in the promotion of the Dipterocarps in the lowland forests, cannot resist the pressures of the demand for land for agricultural developments, and cannot compete with the persuasion of economic potential displayed by the agricultural projects. Furthermore, the Malay Uniform System is not intended for managing of hill forests, which in the face of development pressures must exercise an active part in the economics of the national forest domain.

8.2 FOREST MANAGEMENT CRITERIA

Striving for more efficient utilization of natural resources, the concept of forest management must be based on the following broad criteria:

(*a*) The forests constitute natural resources renewable in perpetuity.

(*b*) The forests in the Pahang Tenggara area are of heterogeneous composition, therefore, integrated utilization of all species is a prerequisite to their rational management. For the same reason a concept of rotation based on any particular species or group of species can no longer apply.

(*c*) The returns from the forest estate must be based on economically acceptable turnover periods.

8.3 BASIS FOR THE DESIGN OF THE PROPOSED SYSTEM

Analyses of the results of the forest inventory survey in Pahang Tenggara area in the virgin and logged-over forests suggest a selective cutting of all species at individual optimum diameter ranges, incorporating judicial canopy manipulation.

The studies indicate that approximately twenty percent canopy opening provides strong enough impulse for release for the ingrowing immature trees, and at the same time affords sufficient protection of the saplings and seedlings from overexposure to the sun. A five-year period between the canopy openings is long enough to exhibit significant changes within the maturing forest stand.

Analyses of stand and stock tables (i.e., number of trees per acre and volume per acre) of various forest types, both in the lowland and the hill forest were carried out, simulating various cutting rates and time cycles. The best balance between the mature inventoried stand (trees 12″ dbh and over), and the potential of growth of the immature inventoried stand (trees 6″ dbh to 11″ dbh inclusive), is achieved by the application of twenty percent volume removal at a five-year cutting cycle.

8.4 THE METHOD

In practical application the system will call for dividing of the forest unit under consideration into five blocks representing the same productive potential. The blocks bearing consecutive numbers from 1 to 5 will be subjected to exploitation in a consecutive annual order. Each year twenty percent of the number of the originally inventoried mature trees will be cut in a different block. Every five years the loggers will return to the same block. In theory, then, all mature trees inventoried originally would be removed within the first 25 years of the completed cycle and would be replaced by the maturing ingrowing trees. The ingrowing trees in the same period would be replaced by the accelerated growth of regeneration, existing and propogated as a result of the removal of the mature trees. However, in reality this picture will be somewhat altered. The faster-growing species will be removed at a faster rate, while the slower-growing species will enjoy protection if so desired.

The trees should be cut at the time they achieve the optimum growth. Indications for the optimum dbh will be given at the conclusion of the present survey. Thorough observation and study of the growth of the individual and groups of species within the managed forest, however, must be carried out continuously to ensure the optimum production.

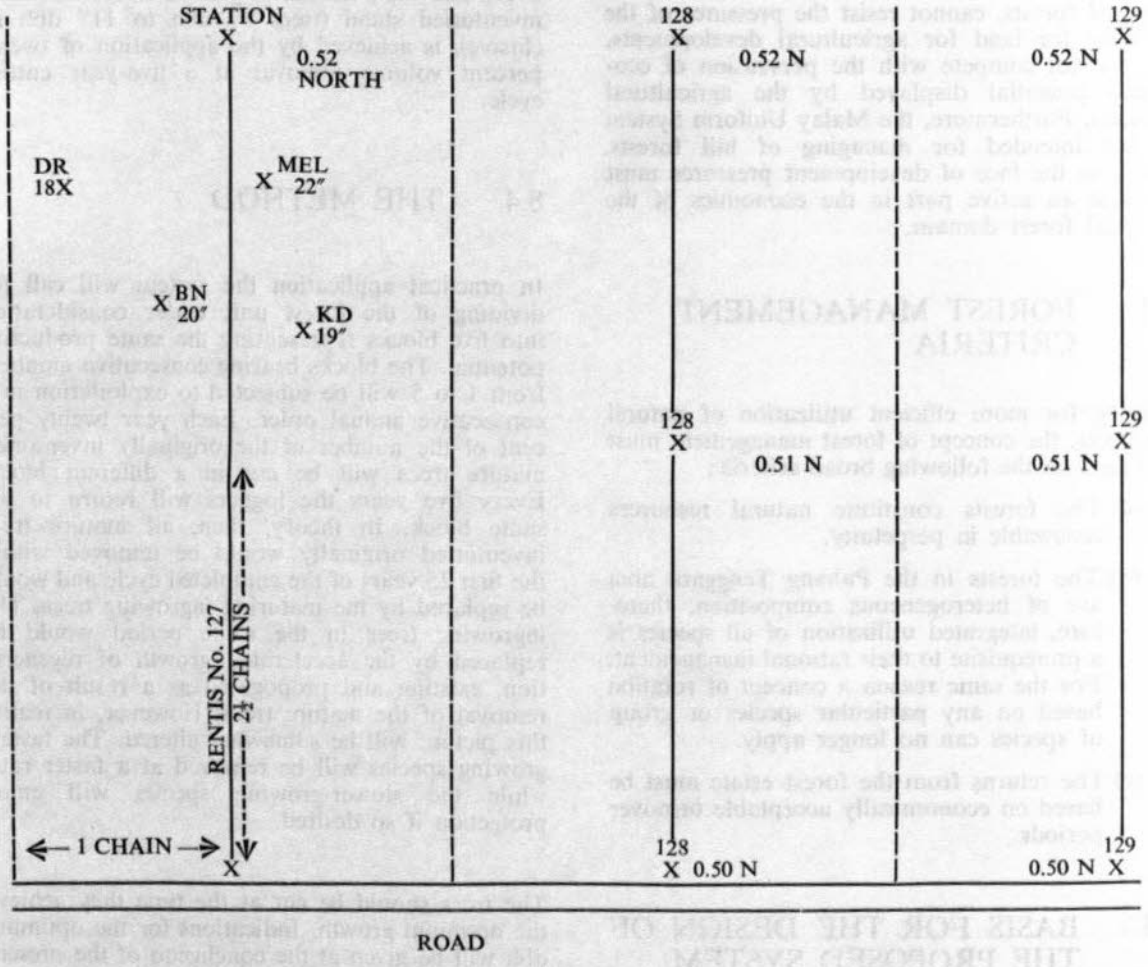
It is expected that the ingrowth and the regeneration within the managed forest will improve and that volume production per unit area will increase with the subsequent cutting cycles.

8.5 TREE MARKING, RENTIS LINES AND ROAD LAY-OUT

The selection of trees for each cutting cycle will be done by visual inspection. Permanent rentis lines will be established in every block. The lines should run parallel to each other and be spaced at two chains distance. A permanent marker, small tree or stake, will be established at every 2½ chains along the rentis. The area 2½ chains long and 2 chains wide represents half an acre. Depending on the quality of the stand, four or five trees will be marked for cutting between each pair of stakes and within a chain width on each side of the line. Marking is done most efficiently with paint applied with a tree marking gun; many models are on the market.

The following diagram illustrates marking and tally method.

Figure No. 8.5a—Schematic Illustration of Tree Marking and Tally Method



It is estimated that three trained forest technicians, each accompanied by an unskilled labourer, will require approximately 4 months to mark trees in a block of some 12 thousand acres in a lowland forest. In hill forest either the number of men or the time would have to be doubled. This estimate is based on 20 working days per month and allows 20 percent for bad weather or other unforeseen handicaps. It is proposed that a team of two men mark trees in the lowland forest along four miles of line daily; that is on 64 acres or 512 trees at a rate of 8 trees per acre. A team would work two miles in the outward direction, cross to adjacent line and work back two miles to the road. In the hill forest only half of that performance could be expected.

The pattern of rentis lines will depend on the layout of the main timber extraction roads, which schematically could run at four miles spacing. The rentis lines would run at right angle to the main extraction roads. Of course the pattern of roads will be variable because of the configuration of the terrain, the variations, however, should not be critical.

Summarizing, the forest unit must be divided into five convenient blocks representing the same productive potential. One year ahead of the exploitation of any block the following programme must be carried out:

(*a*) Timber extraction roads must be laid out in the block and construction undertaken.

(*b*) Timber marking rentis lines must be laid out and established in relation to the main timber extraction roads.

(*c*) Marking of trees in the block must be carried out.

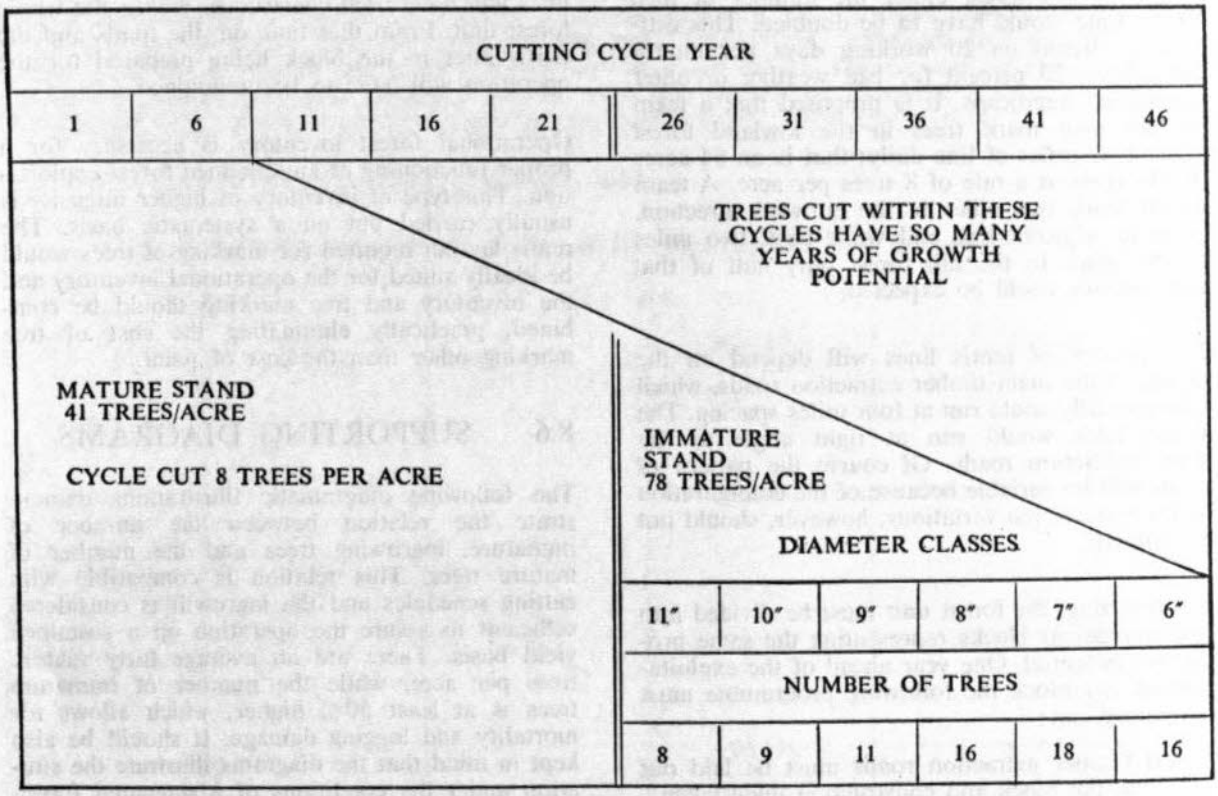
During the first five years all roads and rentis lines will have been constructed within the whole forest unit. From that time on, the roads and the rentis lines in the block being prepared for the operation will have to be maintained.

Operational forest inventory is necessary for a proper functioning of any planned forest exploitation. This type of inventory of higher intensity is usually carried out on a systematic basis. The rentis lay-out required for marking of trees would be ideally suited for the operational inventory and the inventory and tree marking should be combined, practically eliminating the cost of tree marking other than the cost of paint.

8.6 SUPPORTING DIAGRAMS

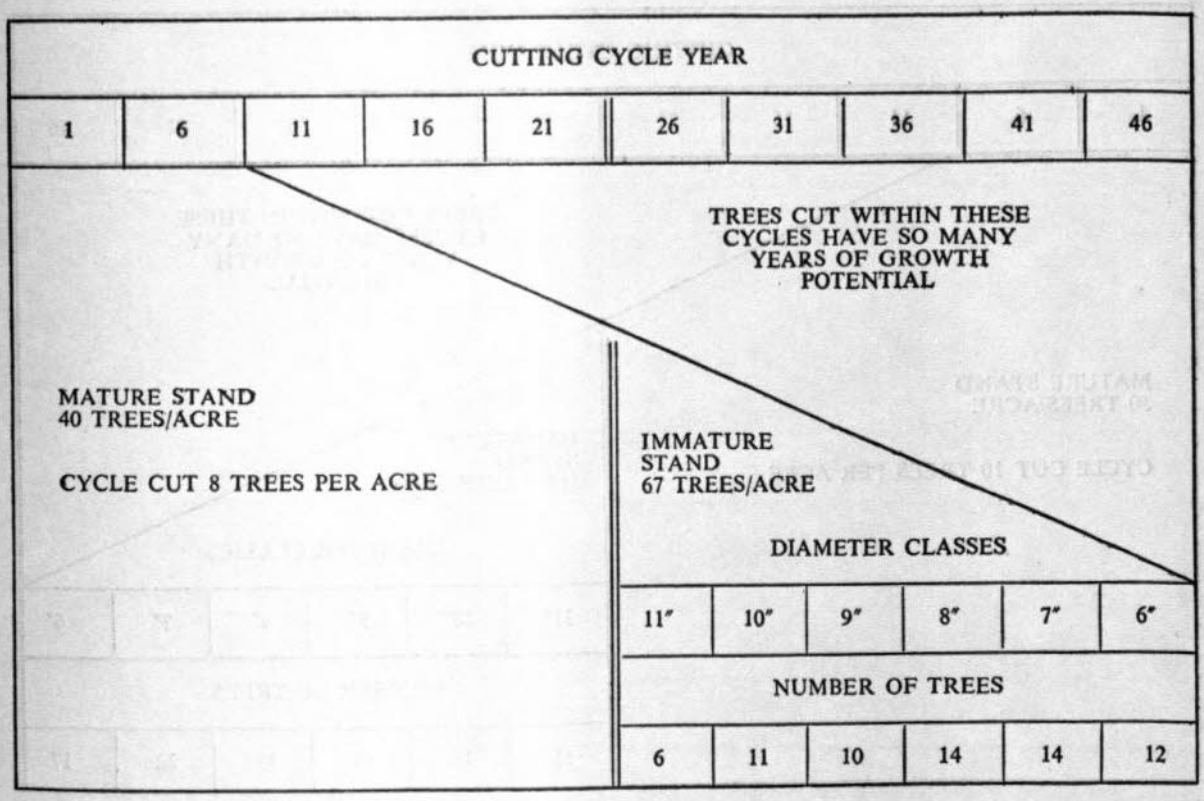
The following diagramatic illustrations demonstrate the relation between the number of immature, ingrowing trees and the number of mature trees. This relation is compatible with cutting schedules and the ingrowth is considered sufficient to assure the operation on a sustained yield basis. There are an average forty mature trees per acre, while the number of immature trees is at least 50% higher, which allows for mortality and logging damage. It should be also kept in mind that the diagrams illustrate the situation under the conditions of a stagnated forest. The implementation of cutting cycles will cause a spontaneous increase of ingrowth and of regeneration, however, it is not being projected in the diagrams.

Figure No. 8.6a—Typical Stand in the Lowland Dipterocarp Forest, Virgin, Used as an Example Type, Code: II-2.1



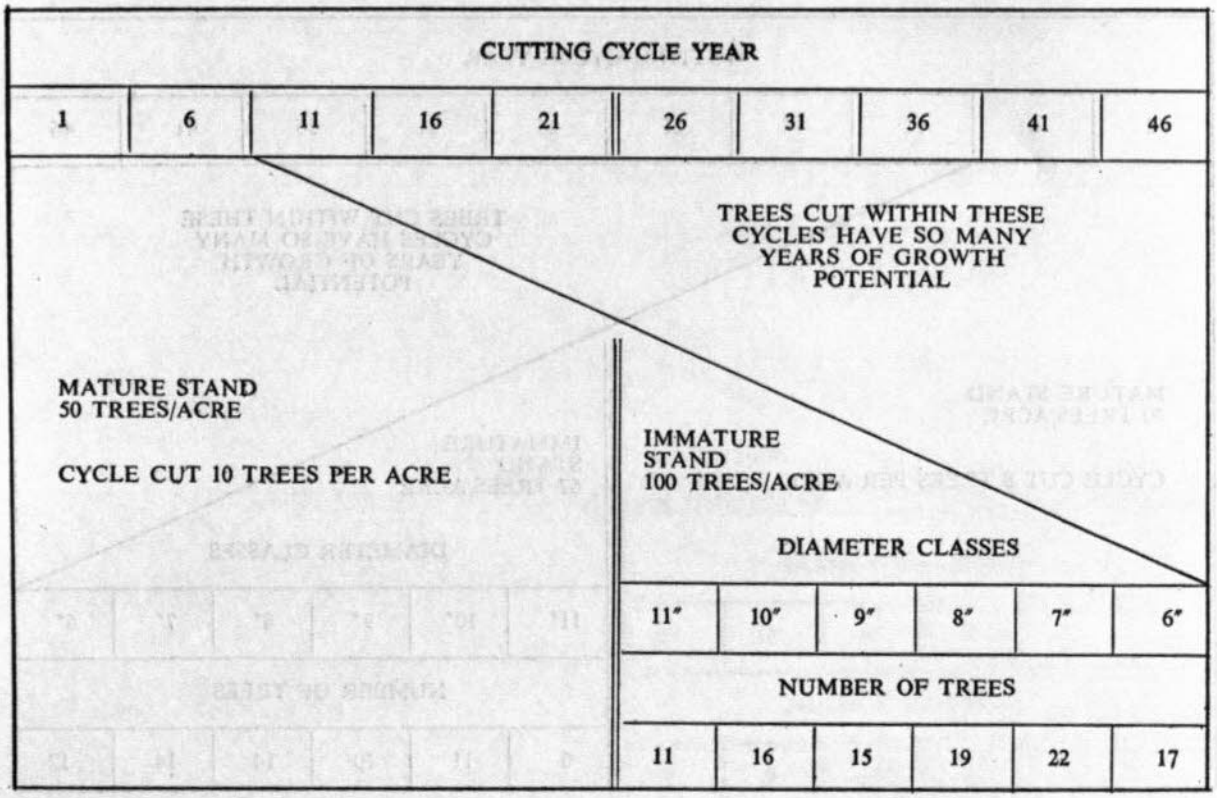
Present mature volume per acre: 3,245 cubic feet.
Tree Averages: 79 cubic feet.
Volume cut per cycle: 632 cubic feet.
Volume utilized per cycle and acre,
At 58% utilization rate: 367 cubic feet.
At 66% utilization rate: 417 cubic feet.

Figure No. 8.6b—Typical Stand in the Lowland Dipterocarp Forest, Virgin, Used as an Example Type, Code: II-2.2



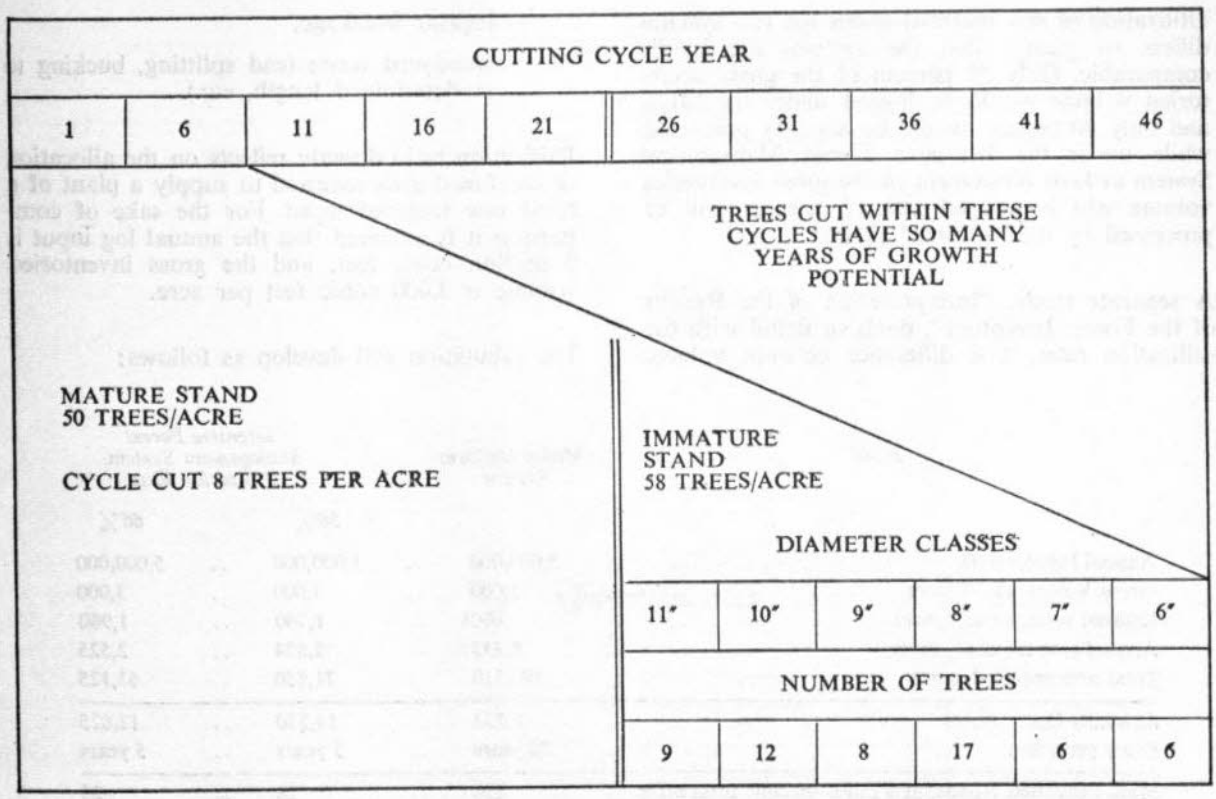
Present mature volume per acre: 3,160 cubic feet.
Tree averages: 79 cubic feet.
Volume cut per cycle: 632 cubic feet.
Volume utilized per cycle and acre,
At 58% utilization rate: 367 cubic feet.
At 66% utilization rate: 417 cubic feet.

Figure No. 8.6c—Typical Stand in the Hill Dipterocarp Forest, Ridge, Virgin, Used as an Example Type, Code: II-1.1



Present mature volume per acre: 3,800 cubic feet.
Tree averages: 76 cubic feet.
Volume cut per cycle: 760 cubic feet.
Volume utilized per cycle and acre,
At 58% utilization rate: 441 cubic feet.
At 66% utilization rate: 502 cubic feet.

Figure No. 8.6d—Typical Stand in the Hill Dipterocarp Forest, Slope, Virgin, Used as an Example Type, Code: II-1.2



Present mature volume per acre: 3,600 cubic feet.
Tree averages: 72 cubic feet.
Volume cut per cycle: 576 cubic feet.
Volume utilized per cycle and acre,
At 58% utilization rate: 334 cubic feet.
At 66% utilization rate: 380 cubic feet.

Relationship between the number of mature trees and the immature, as well as diameter class distribution of the immature are precarious and cause anxiety. Canopy manipulation and regeneration progress will require careful watching.

Logging will require great care as this area is susceptible to soil erosion. Hence 8 trees and not 10 are suggested as cycle cut.

Girth increment of 1.5″ per annum is quoted for several Dipterocarps by C. F. Symington (Malayan Forest Records No. 16, Forester's Manual of Dipterocarps). Of the Non-Dipterocarp species concerning us, many exhibit faster growth, though do not achieve the large diameters possible in the Dipterocarps. At a rate of girth increment of 1.5″ per annum, trees in the 6″ diameter class would measure 28″ dbh at the time of cutting, that is in 46 years. Trees in 11″ diameter class would measure 23″ dbh at the time of cutting, that is in 26 years. This indicates that somewhat higher than present volume per acre can be expected. To maintain sustained yield by volume an average of 18″ dbh is required at the cutting time.

The release will have effect not only on the ingrowing trees but also on the lower diameter classes in the so-called mature trees. The division into mature and immature trees is based on the assumption that trees 12″ dbh have achieved their permanent crown position (height), nevertheless the division is arbitrary, and most species in that diameter class have good increment potential. It is safe to predict that other than for reasons of canopy manipulation and culling there will be no need to cut trees in 12 or 13″ diameter classes.

8.7 COMPARISON WITH THE MALAY UNIFORM SYSTEM

Utilization of raw material under the two systems differs so greatly that the systems are hardly comparable. Only 30 percent of the gross inventoried volume would be logged under the MUS, and only 20 percent would be actually processed, while under the Intensive Forest Management System at least 80 percent of the gross inventories volume will be logged and 58 percent will be processed by the industrial plant.

A separate study, "Interpretation of the Results of the Forest Inventory", deals in detail with the utilization rates. The difference between volume logged and volume utilized, or actual input, results from deductions for:

- — pathological and decadent defect,
- — logging breakage,
- — woodyard waste (end splitting, bucking to predetermined length, etc.).

Utilization ratio directly reflects on the allocation of the forest area required to supply a plant of a fixed raw material input. For the sake of comparison it is assumed that the annual log input is 5 million cubic feet, and the gross inventoried volume is 3,000 cubic feet per acre.

The tabulation will develop as follows:

Items	*Malay Uniform System*	*Intensive Forest Management System Utilization Rate*	
		58%	*66%*
Annual Input, cu. ft.	5,000,000	5,000,000	5,000,000
Gross Volume cu. ft./acre	3,000	3,000	3,000
Utilized volume cu. ft./acre	600[1]	1,740	1,980
Annual area required, acres	8,333	2,874	2,525
Total area required, acres	583,310	71,850	63,125
Annually Open, Acres	8,333	14,370	12,625
Every year, for:	70 years	5 years	5 years
Main extraction Roads, at 4 miles spacing, total miles	228	28	25
Annually constructed road—miles	3.26	5.6	5.0
Every year, for:	70 years	5 years	5 years

[1] These figures are based on utilization of timber in present forest stand and not in the one that could be expected in 70 years from now.

Items	*Malay Uniform System*	*Intensive Forest Management System Utilization Rate*	
		58%	*66%*
Rentis for operational inventory and tree marking at a spacing of	5 chains	2 chains	2 chains
1 Mile of Rentis serves	40 acres	16 acres	16 acres
Total Rentis miles:	13,583	4,491	3,945
Annually to construct—Miles	208	898	789
Every year, for:	70 years	5 years	5 years

The above comparison of the requirements of roads refers to the main extraction roads within the exploited forest area. The example is based on a four mile spacing between the roads. Other spacing may be dictated by the conditions of the terrain. The relation between the roads requirements for the discussed systems will remain the same regardless of the spacing used.

The access roads will differ with every locality and, therefore, are not analysed here. It is obvious, however, that they would be much longer under the MUS than under the Intensive Management System because of the difference in the size of the area in each case.

9.0 APPENDIX D

9.0 TREE FARM LICENSE AGREEMENT

A sample Tree Farm License Agreement is attached. This sample agreement has been adapted from a document currently in use in the Province of British Columbia, Canada. It is not suggested that the sample agreement should be considered as a final document, or even approaching a final document, but rather one which covers the main agreement conditions from a forestry point of view and which covers the intent of a Tree Farm License Agreement. Such an agreement will protect the interest of both the Licensor and Licensee, however, it must be made to comply with the applicable laws of both the State of Pahang and the Federation of Malaysia.

No suggestions have been made regarding amounts of deposits and performance bonds. These should be substantial enough to encourage compliance with the conditions of the agreement, yet also in keeping with current practice in Malaysia.

Although the Agreement will be signed by the Government of the State of Pahang, the areas covered by the Agreement are within the Pahang Tenggara regional development area. We recommended, therefore, that the Licensee be directly responsible to the Pahang Tenggara Development Authority for the planning and forest management phases of the Tree Farm License Agreement, while administration procedures remain within the jurisdiction of the State Forest Officer.

TREE FARM LICENSE AGREEMENT

The Agreement shall be made between the Government of the State of Pahang referred to hereafter as the Government, and a corporation duly incorporated under the laws of Malaysia or the State of Pahang, whichever is applicable, hereafter referred to as the Licensee.

The Agreement will grant a Tree Farm License covering government lands as specified in the Agreement. This license will grant these lands for the sole use of the Licensee for the purpose of growing continuously successive crops of forest products to be harvested in approximately equal periodic cuts adjusted to the sustained yield capacity of the lands covered by the Tree Farm License.

The Agreement is made in consideration of payments, agreements, stipulations to be made and observed by the Licensee as follows:

1. The Tree Farm License may be referred to as the.....Tree Farm License and is numbered....., and is entered on the official maps of the State of Pahang.

2. The Tree Farm License is given for the maintenance of the manufacturing plant or plants, owned or to be constructed as agreed between the Government and the Licensee. The said plant or plants shall be capable of using an agreed upon part of the allowable cut from the Tree Farm License and shall be maintained in operation in sufficient continuity to utilize and process this agreed upon amount.

3. The Licensee shall manage the Tree Farm License in accordance with provisions of the appropriate Acts, and in accordance with a Management Working Plan as approved by the Government and its agents.

4. The terms of the Agreement shall be for 30 years subject to the provision of this Agreement and compliance with the Management Working Plan. The Tree Farm License shall be renewable but subject to renegotiation of terms and conditions of the contract according to regulations in force at the time of application for renewal.

5. The Tree Farm License area will include all Government lands not alienated at the date of contract, together with all lands owned or controlled by the Licensee, within the area outlined on the map and attached plan.

6. Any acquisition of lands by the Licensee within the boundaries described above may be included in the Tree Farm License at the discretion of the Government.

7. The Government may withdraw areas from the Tree Farm License for forest experimental purposes, parks, rights of way, or for purposes of higher use. If such withdrawals exceed one percent of the productive capacity of the area, adjacent government lands may be substituted.

8. Notice will be given to the Licensee six months in advance of withdrawals, and compensation paid to the Licensee for losses sustained by such withdrawals. If the amount of compensation payable cannot be agreed upon between the

Government and the Licensee, an arbitration procedure acceptable to both parties shall be devised and used to settle the dispute.

9. Non-productive land within the Tree Farm License area may be withdrawn at the discretion of the Government.

10. The Tree Farm License Agreement covering government lands shall not limit the use of the lands at the discretion of the Government for other purposes such as mining, hunting, fishing, hydro-electric development, or any other use which does not materially prejudice the right of the Licensee to employ the land for the purpose of growing successive crops of forest products under the terms of the Tree Farm License.

11. It shall be understood that this Agreement does not include water rights or foreshore rights, and all such rights vested in the State Government shall remain in the same state.

12. The Government may direct the licensee to have surveyed and defined on the ground, and at the Licensee's expense, any or all boundaries of the Tree Farm License area which he may deem necessary to have so surveyed and defined.

13. The Licensee agrees to keep in growing timber stock all areas of the Tree Farm License, and will do so to standards of stocking as defined from time to time by the Government or its agent.

    This requirement will apply also to areas denuded or degraded before the signing of the Agreement, and the Licensee may be required to restock at a predetermined rate, not to exceed 10% of the denuded area or 1,000 acres annually whichever is the lesser.

14. (*a*) The overall management of the Tree Farm License area as covered by this Agreement shall be carried out in accordance with the Forest Management Plan as submitted not later than 4 years after the signing of this Agreement and as approved by the Government. The said Forest Management Plan shall be based on complete forest inventory data collected and compiled to a standard set by the Government and the forest management principles shall be based on (*the Intensive Forest Management System as detailed in Study Paper No. 11, and section 8 of this report*).

    (*b*) A 5-year Working Plan shall be submitted for each successive 5-year period and shall give detailed forest development plans for the area covered by this Agreement. The proposed development shall be in accordance with the principles as set down in the Forest Management Plan required by Clause 14 (*a*) above.

    The first 5-year Working Plan shall be submitted along with the Forest Management Plan and shall be based on the latest forest inventory data available at time of submission. All subsequent Working Plans shall be submitted for approval by the Government at least 6 months prior to the expiry of currently approved Working Plans.

15. The object of each succeeding Working Plan shall be to implement sustained yield in equal annual or periodic cuts, and the plan may embody any method of attaining that objective, as approved by the Government.

    Should the current Working Plan need revision due to emergency conditions, such as insect or disease infestations, so that changes are required, these may be carried out with the approval of or at the request of the Government.

16. In the event that the Licensee and the Government cannot agree as to the allowable cut, sequence of cutting, or any revision to the cutting plan, the Government shall have the final decision as to the cause of action to be taken. The Annual Allowable Cut shall not exceed 6,250,000 cubic feet unless specific approval, in writing, has been obtained from the Government.

17. The cutting of trees on the Tree Farm License shall be in accordance with the current Working Plan and shall be dependent upon the issuance of an Annual Cutting Permit defining the area to be logged. The rate of Royalties and premiums shall be determined in accordance with the practices current at the time of issuance of the Cutting Permit. The Cutting Permit application shall be submitted for approval at least 3 months prior to the expiry of the current Cutting

Permit. Any cutting outside the Cutting Permit area will be subject to penalty as determined by the Government which shall not exceed twice the normal fees. Cutting within a Cutting Permit application area applied for by the date required, but not yet approved, would not be subject to penalty.

18. All timber harvested in the Tree Farm License area shall be scaled in accordance with current timber scaling practice.

19. The Licensee agrees to establish pilot plantations of fast growing tree species both coniferous and deciduous as a means of determining ways to increase the productive capacity of the Tree Farm License area. The data obtained from the pilot plantings shall be used to determine the possible establishment of commercial fast growing plantations within the Agreement area.

    The extent of this work with fast growing species, shall be by agreement of and with the approval of the Government.

20. The Government agrees to reimburse in whole or in part the Licensee for certain silvicultural and forest management costs incurred by the Licensee in the operation of the Tree Farm License area. The manner in which these approved costs are to be audited, and the manner in which the reimbursements shall be made shall be determined by the Government.

21. The Licensee submits herewith a deposit of $.....(*Amount*), receipt of which is acknowledged. The said deposit shall be held for the purpose of ensuring compliance with the terms of the Agreement by the Licensee.

22. The wood harvested annually from the Tree Farm License shall not fall below 50% or exceed 150% of the approved annual cut, provided however that for each successive 5-year period the actual cut shall be within 10% of the total approved allowable cut for that period.

    Penalties for non-compliance with the above, shall be normal Royalties for the amount below the allowable cut, and double Royalties for that portion of the cut above the stated limits.

23. Should the Agreement be cancelled by reason of default or breach of the Tree Farm License Agreement by the Licensee, all moneys on deposit with the Licensor under the terms of the Agreement shall be payable to the Government for damages.

24. All roads on lands within the boundaries of this Tree Farm License area shall be held available for public use at times and under conditions as determined by the Government. It should be understood that such public use of the roads will not restrict the use of these roads by the Licensee for the purposes of operating the Tree Farm License.

25. The Licensee shall employ a professional Forester, acceptable to the Government, capable of carrying out the terms of this Agreement. The Management Working Plan and all revisions and amendments thereto shall be signed by an approved professional Forester, and by at least one officer authorized to sign contracts on behalf of the Licensee.

26. The Tree Farm License Agreement cannot be assigned, sold, or transferred in any manner to another company without the written approval of the Government and in accordance with provisions and requirements as determined by the Government.

27. The Tree Farm License Agreement may be amended by mutual agreement between the Licensee and Licensor, and such amendments must be in writing, duly signed by both parties and attached to the original Agreement.

28. Should the Company holding the Tree Farm License Agreement become bankrupt, the Government may cancel the Agreement and dispose of all monies and assets in accordance with the laws of the State of Pahang.

29. Any notices required to be given to the Licensee by the Government shall be delivered by Registered Mail or delivered to the registered office of the Licensee. The date of delivery shall be deemed the effective date of the notice.

30. (*a*) This Tree Farm License Agreement can be terminated at any time by mutual consent of both parties.

    (*b*) The Licensee may terminate the Tree Farm License on two years notice in writing to the Government, subject to the following conditions:

        (i) All monies held as security deposit or by whatever means

may be declared payable to the State of Pahang by the Government.

(ii) All tenures which may have reverted to the State of Pahang through the provision of the Agreement shall not revert to the Licensee.

(iii) All improvements on State lands shall become the property of the State and the Licensee shall have no claim for compensation with respect to these improvements. At the Government's discretion, however, the Licensee may be permitted to remove those improvements which will not cause damage to the Tree Farm License area, or which on removal would not adversely affect future operations within the area concerned.

(iv) All Cutting Permits issued under the Agreement shall terminate along with and at the same date as the Agreement.

(v) All outstanding monies shall be paid by the Licensee with respect to Royalties, premiums, taxes, etc.

(vi) All rights granted under the Agreement will be cancelled or terminated effective the termination date of the Agreement.

31. In the event the Tree Farm License is terminated or cancelled, the other tenures owned or controlled by the Licensee included within the Tree Farm License area shall be forfeited to the State of Pahang and shall not be encumbered by any agreements, understandings, commitments or in any other manner.

32. This Tree Farm License is issued on the understanding that the Licensee will build and have in operation by..... a forest products conversion plant described as follows:.....
.....
.....
.....
capable of utilizing annually.....
.....
.....
.....cubic feet, true measure.

33. The Licensee herewith delivers to the Government a performance bond of (*Amount*) of lawful money of Malaysia as a guarantee of performance stated in Clause 33 above. The said (*Amount as Above*) performance bond shall be released and returned to the Licensee when the conversion plant described above in Clause 33 is completed and placed in operation.

34. The Licensee agrees to submit to the Government at regular 3 month intervals from the date of the signing of this Agreement progress reports, with pertinent data concerning the design, tendering and construction of the prescribed conversion plant(s).

35. (*a*) In the event the Licensee fails to have the conversion plant described in Clause 33 in operation on the agreed date the Government may cause the performance bond to be forfeited, and this Agreement terminated.

(*b*) If the Licensee has been delayed by circumstances beyond his control, an extension of time shall be granted by the Government for a period at least equal to the period of delay.

(*c*) The Government, at its discretion, may waive any default or extend the time for completion and commencement of operations of the agreed upon conversion plant.

(*d*) The Government, at its discretion, may allow change or variance in the design and construction of the conversion plant(s) if, in its opinion, changes in circumstances warrant such variances.

(*e*) Any extension in time granted by the Government for the construction and commencement of operation of the conversion plant(s) in sub-classes (*b*) and (*c*) above, shall not change the term of the Tree Farm License as stated in Clause 4.

36. The Licensee shall use such techniques as are available and practical in the construction and operation of the conversion plant(s) to safeguard the public generally against deleterious effects which may result from the processing of the wood products.

37. This Agreement is subject to provisions of applicable Acts of the State of Pahang and such amendments and regulations which may be made pursuant to the applicable legislation.

38. In this Agreement:

"Applicable Acts" means legislation of the State of Pahang concerning the disposal of, and or possession of Forest land.

"Approved", unless otherwise stated, means approved by the Government.

"Denuded", "Degraded", or "denuded lands", means any forest land within the Tree Farm License area from which all mature or immature commercial tree species have been removed, logged or destroyed, and on which young trees have not been established in sufficient numbers to produce a valuable crop according to standards set by the Government or its agents.

"Higher economic use", means that use which in the opinion of the Government will contribute most to the good and welfare of the State of Pahang, including non-monetary uses.

"The Government", refers to the Government of the State of Pahang responsible for the forest resources of the State.

"Other tenure", means any title, license, lease, or ownership where the licensee has the right to cut timber or land with the boundaries of the Tree Farm License.

"Forest Management Plan" means the management plant submitted as required in this Agreement which is to detail the general and overall forest management policies for the first rotation of 25 years for the Tree Farm License area.

"Working Plans" which are to be submitted at 5 year intervals are to cover in detail the proposed development, allowable cuts, and specific management plans for the 5 year period covered by the plan.

"Cutting Permits" are submitted and approved annually defining the areas to be cut and the Royalties and premiums to be paid during each year of operation.

39. This License shall be to the benefit of and shall be binding not only on the signatory parties, but also on the successors in office of the Government and the successors and Assigns of the Licensee.

IN WITNESS WHEREOF the Government has executed before those present and the Licensee has hereunto affixed its corporate seal by the hands of its proper officers in that behalf.

SIGNED SEAL AND DELIVERED in the presence of:

....
for the State of Pahang

THE COMMON SEAL OF THE LICENSEE was hereunto affixed in the presence of:

.....

.....

10.0 APPENDIX E

10.0 SPECIAL COMPLEXES

Roundwood resources sufficient for a minimum of 17 years supply for conversion plants will be generated by the planned agriculture clearing programme in the Pahang Tenggara area. Resources of over 900,000 Tons (50 cu ft) will come from land not committed to FLDA or the private sector at this time but must be cleared by 1980. This preliminary volume is based on 12T (50 cu ft) average per acre recovery and has been estimated low due to the clearing schedule required.

Roundwood sufficient to give a further 10 year (1990) plant life will be available from agriculture land east of Endau Park scheduled for clearing 1981-1990. To assist in utilizing a proportion of the roundwood resource a potential exists for the establishment of three (3) Special Complexes in the Lanjut areas described in section 3.5 of this report. These operations based on an implementation date of January 1, 1973 for the first unit could come into production by July 1, 1974 and the others follow on a one year schedule or sooner if desired.

10.1 SYSTEMS DESIGN CRITERIA

Each Complex would include a sawmill, pre-dry kiln system and a planer moulding plant.

Logs for the sawmill will be delivered to the sawmill log deck from the short log storage area by mobile log loaders. Logs will pass through a Rosser Head type log debarker before loading onto the Breakdown Carriage. The log debarker will more than repay its initial cost by longer saw life and higher grade recovery due to clean logs being presented to the Breakdown Band Mill. Cants (rough planks over 3″ thick) from the Breakdown Band Mill will be further remanufactured on a Pony Rig Band Mill.

To allow further remanufacture an edger and line bar resaw assembly will work in conjunction with the trimming and sorting facilities. The sawn timber will be conditioned for further remanufacture in Pre Dry and Dry Kiln systems. Pre-drying is essentially a method for stimulating favourable and faster air drying conditions.

Dry kilns are an essential part of the controlled seasoning installation. They provide for final drying to the moisture content required by the end users and also for moisture conditioning and drying stress relief treatments.

Conditions in a pre-dryer may be controlled to provide, within limits, any relative humidity, so that the process may be used to dry timber to a final moisture content of, say, 12%. However, this usage is not common, and it is more usual to pre-dry down to an "air-dry" condition of some 20% and finish the drying task in the Dry Kilns. By transferring the stacks to a kiln at this stage and using more severe conditions, it is possible to achieve a shorter total drying time. Kiln Drying from the green condition is normally uneconomical for those hardwoods which are comparatively impermeable and collapse-susceptible, and which must not be exposed for prolonged periods to temperatures above 110°F until the moisture content falls below fibre saturation point.

The planer-moulding mill will remanufacture the kiln-dried sawn timber into dressed stock, moulding and pattern with finish suitable to meet international standards. Throughout the sawmill flow emphasis has been placed on maximum recovery of sawn timber. The basic emphasis on recovery, tempered with economic reasoning must be followed through the production flow to the finished product.

10.1.1 Basic Design Criteria

Implementation Date ...	January 1, 1973 (first unit)
Annual Round Log Budget	1,800,000 cu ft (36,000 T-50 cu ft)
Sawmill Recovery Factor	56%
Log Specifications ...	*Log Yard:*
(*a*) Maximum Diameter	as develops
(*b*) Minimum Diameter	12″ (Year 2)
(*c*) Maximum Length ...	24′
(*d*) Minimum Length ...	8′

10.2 EQUIPMENT LISTS

10.2.1 Sawmill and Refuse Control System

Log Storage Deck

Log Stop And Loader

Log Turner Assembly And Nigger

Breakdown Carriage

Breakdown Carriage Feedworks
Breakdown Carriage Trucks And Sheave
Headrig Bandmill
Sec. 1 Headrig Rollcase
Sec. 2 Headrig Rollcase
Sec. 3 Headrig Rollcase
Breakdown Resaw Cant Deck
Breakdown Resaw
Splitter Resaw Infeed Storage Deck
Splitter Resaw
Splitter Resaw Outfeed Belt
Pony Rig Jump Chain Transfer
Pony Rig Cant Storage Deck
Pony Rig Loader Assembly
Pony Rig Carriage
Pony Rig Feedworks
Pony Rig Tracks And Sheave
Pony Rig Bandmill
Sec. 1 Pony Rig Rollcase
Sec. 2 Pony Rig Rollcase
Pony Rig Transfer to Edger
Head Rig Transfer to Edger
Edger Infeed Rollcase
Edger
Edger Outfeed Rollcase
Accumulation Table
Grading Table
Sort Gate
Hula Trim Saw Assembly
Belt Conveyor to Green Chain
Treating Tank Infeed Transfer
Treating Tank
Green Chain Crowder Transfer
Sec. 1 Green Chain
Sec. 2 Green Chain
Filing Room Equipment
Air Compressor
Saws
M.C.C. And Controls
Air System Component
Main Mill Conveyor
Main Burner Conveyor
Burner Assembly
Slasher Assembly
Pony Rig Conveyor
Trimmer Conveyor
Edger Conveyor
M.C.C. And Controls
Hog Conveyor
Hog Assembly
Fuel Storage Conveyor

Total Budget Estimate ...	$1,384,000
Estimated Connected Horsepower	1,125 H.P.

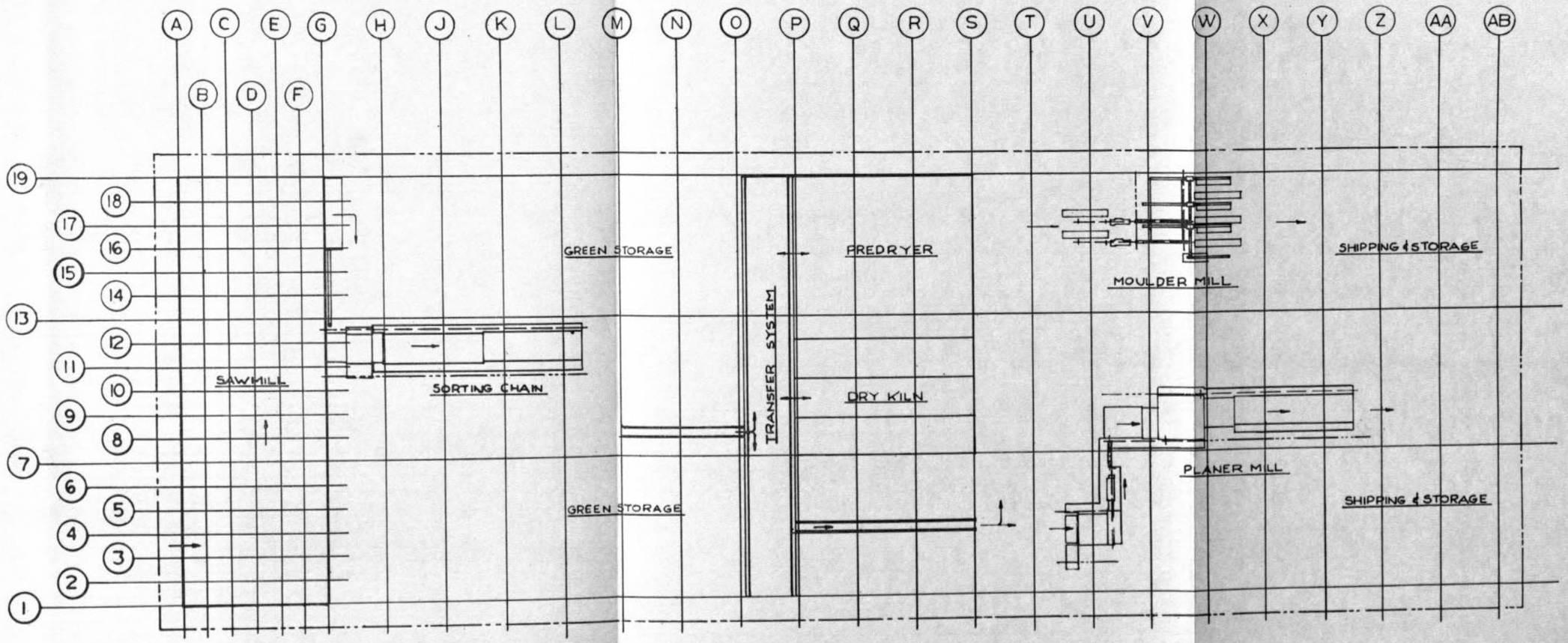
10.2.2 Pre-Dry and Kiln Systems

6 Line—86′ Pre Dry
3 Single Stack 86′ Kilns
Lift Truck
Transfer Truck
Sample And Test Equipment
Doors
Rail
Main Steam Line
M.C.C. And Controls

Total Budget Estimate ...	$293,000
Estimated Connected Horsepower	120 H.P.

10.2.3 Planer Mill System

Planer Storage Table
Fast Feed Table
6×12 Planer
Outfeed Belt
Outfeed Camel Back
Trimmer Accumulation Table
Trimmer Assembly
Grading Table



KAJIAN PERANCHANGAN
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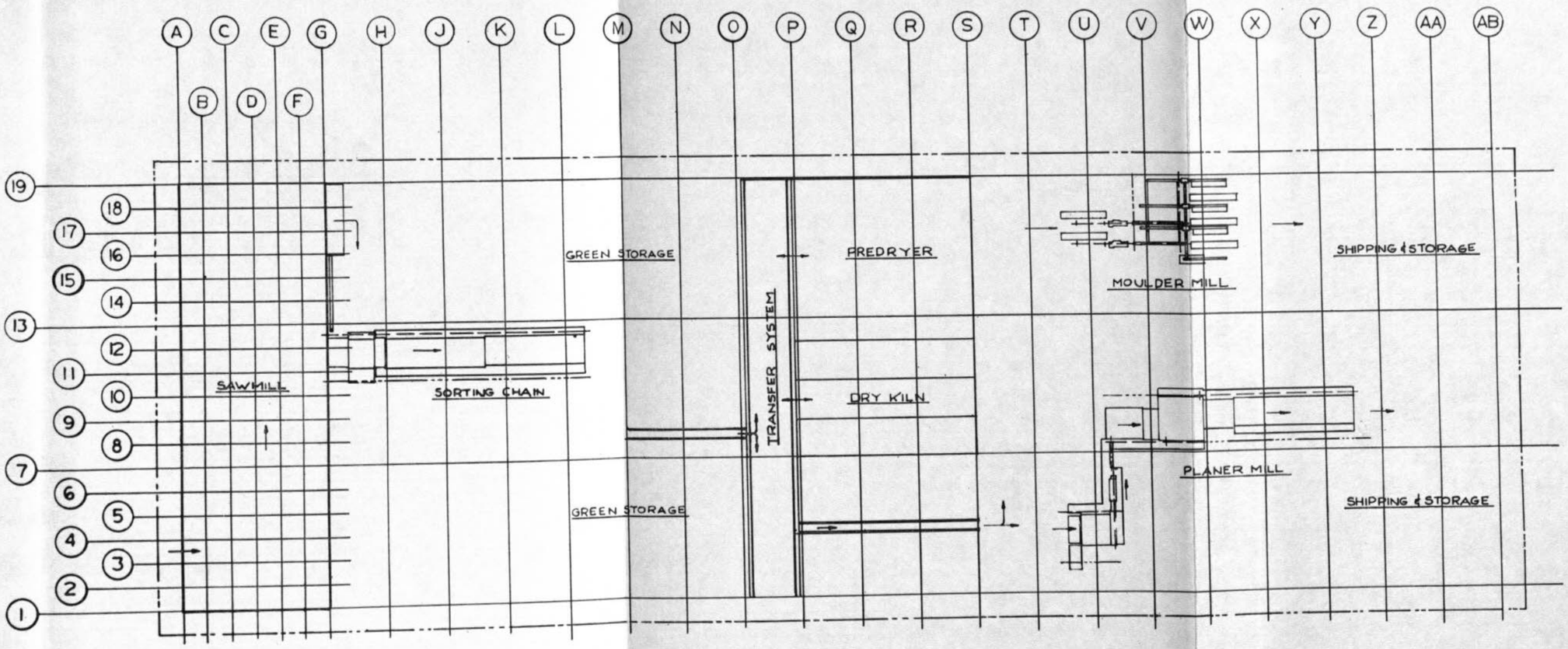
REGIONAL MASTERPLANNI
For THE GOVERNMENT OF M
THE STATE GOVERNMENT O

SPECIAL
COMPLEX FLOW

Planning Consortium Me
FENCO • ECOS • GARDINER •

SCALE	DATE
1":30':0	APR

Fig. 10.1a



KAJIAN PERANCHANGAN KAWASAN
PAHANG TENGGARA
REGIONAL MASTERPLANNING STUDY

For THE GOVERNMENT OF MALAYSIA & THE STATE GOVERNMENT OF PAHANG

SPECIAL
COMPLEX FLOW PLAN

Planning Consortium Members
FENCO • ECOS • GARDINER • CHARNELL

SCALE	DATE
1" = 30'-0	APRIL 13, 1972

Green Chain
Exhaust System
M.C.C. And Controls
Grinding Room Equipment
Heads And Knives
Air Compressor Assembly

Total Budget Estimate	...	$370,500
Estimated Connected Horse-power	... ...	512 H.P.

10.2.4 Moulding Mill System

5×4 Moulders (2)
Outfeed Belts And Shears (2)
Moulding Transfer Table
Trimming Saws (3)
Grinding Room Equipment
Exhaust System
Heads And Knives
Waste Conveyor
M.C.C. And Controls
Gang Rip Saw
Resaw

Total Budget Estimate	...	$239,000
Estimated Connected Horse-power	... ...	259 H.P.

10.2.5 Material Handling

Lift Trucks
Straddle Trucks
Log Loaders (1)

Total Budget Estimate	...	$304,000

10.2.6 Steam Plant

Steam Plant Unit (10 to 12 lbs. per hour)
Electrical Panel
Piping And Steam Line
Feeder Conveyor

Total Budget Estimate	...	$304,000
Estimated Connected Horse-power	... ...	45 H.P.

10.2.7 Power Generating System

10.2.7.1 Power Requirement

Sawmill	...	855 H.P.
Waste System	...	300 H.P.
Kiln System	...	120 H.P.
Planer System	...	512 H.P.
Moulding System		259 H.P.
Steam System	...	45 H.P.
Lighting System And Misc.	...	200 H.P.
		2,261 H.P. (approximately 1,100 K.W.)

10.2.7.2 Generating Units

1 — 500 K.W. units.
2 — 330 K.W. units.
Control Panels.
Transformer and Control assemblies.

Total Budget Estimate: $485,000

10.2.8 Summary: Equipment Budgets

	Local	*Foreign*	*Total*
	$	$	$
Sawmill and Refuse Control System	599,000	785,000	1,384,000
Pre Dry—Kiln System	38,100	255,500	293,600
Planer Mill System	170,000	200,500	370,500
Moulding Mill System	82,000	157,000	239,000
Material Handling	—	304,000	304,000
Steam System	94,000	210,000	304,000
Power Generation System	485,000	—	485,000
TOTAL BUDGET ESTIMATES	1,468,100	1,912,000	3,380,100
Freight and Handling	38,400	370,000	408,400

10.3 OTHER BUDGETS

10.3.1 Site and Services

Site — 15 acres.

Site Clearing.

Site Preparation and Earthwork.

Culvert and Drainage.

Roads.

Water Supply

Security Fencing

Total Budget Estimate ... $209,500

10.3.2 Buildings

Sawmill	15,550 sq. ft.
Green Storage	51,840 sq. ft.
Pre-Dry Kilns	12,780 sq. ft.
Planer Moulding & Storage	64,800 sq. ft.
Steam Plant	12,000 sq. ft.
Miscellaneous Structures ...	4,000 sq. ft.
Total Area ...	160,970 sq. ft.
Total Budget Estimate ...	$817,500

10.3.3 Equipment Installation

Mechanical	$212,200
Electrical	114,800
Total Budget Estimate ...	$327,000

10.3.4 Project Engineering

Production flow and design and site, structural and general supervision.

Total Budget Estimate ... $460,000

10.4 PROJECT SUMMARY

10.4.1 Project Budget

Area	*Local*	*Foreign*	*Total*
	$	$	$
Equipment	1,468,100	1,912,000	3,380,100
Freight and Handling	38,400	370,000	408,400
Site and Services	209,500	—	209,500
Buildings	817,500	—	817,500
Installation	327,000	—	327,000
Engineering and Disbursements	460,000	—	460,000
TOTAL ..	3,320,500	2,282,000	5,602,500

10.5 PRODUCTION MARKETING

A long range general marketing analysis has been completed and includes past trends in Major World Markets and relates these trends to various known indicators and thus obtains a conservative forecast of future requirements of Malaysia as a whole. The analysis is presented as section 15.0 Appendix I to this report.

There are six basic elements to consider when exporting any product overseas. These are:

(*a*) An extensive knowledge of the market concerned.

(*b*) An existing or an anticipated demand.

(*c*) A product tailored to meet this demand.

(*d*) Adequate transportation to handle the shipment.

(*e*) Generally, a superior product specification, which gives a selling price advantage.

(*f*) A satisfactory promotion campaign.

A thorough study of these points usually determines the most promising markets to enter. Fortunately, for Malaysia and in particular, the Pahang Tenggara area, all of the six basic

elements can be considered as being able to be met. Items (*a*) and (*f*) will require more detail work both by the Government and by the timber industry for future stability.

The growth in world-wide consumption of tropical hardwood products continues with all indicators to a future increase in volume requirements. Malaysia with its existing political and economic stability and its access to world-wide shipping systems, coupled with its adequate volumes of tropical hardwoods, raw material resources, stands on the threshold of a fairly extensive expansion into completely finished wood products for export.

Four basic market areas can be serviced from the "Special Complexes":

(1) Europe and the European Economic Community (E.E.C.) which will include United Kingdom.

(2) The North America continent including the United States and Canada.

(3) Australia.

(4) Japan.

10.6 SPECIE MIX

A system of specie grouping established in other operations in Malaysia could be used in these complexes. Related to species available in the Pahang Tenggara resources, a modified pro-forma specie chart has been compiled, indicating specie mixes or grouping generally acceptable to a production and sales programme.

10.6.1 **Group 1**

Meranti Red

Nemesu

Nyatoh

Yellow Meranti

Seraya

Meranti Tembaga

Meranti Kepong

Meranti Melantai

10.6.2 **Group 3**

Keruing

10.6.3 **Group 5**

Mengkulang

Kedondong

K. Semangkok

Medang

Merawan

Mempisang

Penerahan

Kelat

Perak

Kulim

10.6.4 **Group 6**

Jelutong

Sesendok

10.6.5 **Group 9**

Keledang

10.6.6 **Group 10**

Kapur

Keladan

10.7 PRODUCT SALES BUDGETS

To be able to establish a reasonable and sound Product Sales Budget for 1974 onward a fairly extensive review of existing prices, cutting programmes (estimated) and other operating detail has been evaluated. This study can in no way be construed as a firm marketing policy but is indicative of potential sales budgets based on current and indicated future sales trends.

Estimated Average Sales Budgets for 1974/75 onward are based on following assumptions:

(*a*) Export 80%—Local 20%.

(*b*) Local Sales Average $125/T F.O.B. Mill.

(*c*) Export volumes are all surfaces stock into S4S, mouldings and pattern work.

(*d*) All average prices are based on Rough Measure for calculating purposes F.O.B. Klang.

(*e*) Sales Average are budgetted for 2% increase per annum after year 4 (1976).

(*f*) Average Sales Prices have been calculated on estimated production programme utilizing the specie mix available and existing marketing acceptance to grades, sizes and shapes.

Table 10.7—Average Sales Potential: Basis of Estimated Weighted Sales Average for 1974/75 Onward

Products	SPECIE GROUP						Estimated % of Total Productive	Price used	Price Range 1972 F.O.B. Klang
	1	3	5	6	9	10			
(1) Boards S4S—Selbet	X	X	X	X	X	X	15%	$400	$396 - $428
(2) Boards S4S "C" and "D" clear ..	X	X	X	X	X	X	15%	310	277 - 367
(3) Moulding R. L. No. 1 grade ..	X		X	X	X	X	7%	610	600 - 744
(4) Moulding Pre-Cut No. 1 Grade..	X		X	X	X	X	10%	650	650 - 770
(5) Moulding Pre-Cut No. 2 Grade..	X		X	X	X	X	10%	410	410 - 625
(6) Jambs (sets)	X				X	X	3%	550	547 - 636
(7) Decking—specified length ..		X			X	X	10%	310	301 - 345
(8) Flooring		X			X	X	10%	326	316 - 415
(9) Local							20%	125	74 - 158
							100%		

Weighted Average Sales Price 1974/75.
F.O.B. Port Klang: $360.00 per ton (50 cu. ft.).

10.8 PRO-FORMA STATEMENT OF POTENTIAL PROFIT AND LOSS

An indication of the potential profit and loss of a "Special Complex" follows. Taking into consideration the roundwood input to the complex will come from an agriculture clearing programme, will mean the round wood will be of useable species and size as dictated by the schedule of clearing. This generally higher grade and limiting of species will have an increase effect on the average product mix resulting in a possible higher sales average than normal.

Based on assumed operating costs, production schedule and sales income, it is indicated a complete write off of investment could take place before year 6 of production. Production in year one would require 25,000 T roundwood building up to 36,000 T (50 cu. ft) at end of year two of production. A log cost of $50 per ton (50 cu. ft) delivered to the log yard has been used. Logging could possibly be done by contractors under company control or by its own logging crews. Salary rates used, have been based on anticipated hourly rates effective in July, 1974 plus a 12% fringe benefit factor and a $.10 per hour night shift differential. All labour costs budgetted and used reflect a build up of the required labour force up to full production. Hourly salary ranges of job category within the range of various skill classifications are based on 2,200 hours annually which include seven paid holidays.

Skill Classification	Hourly Rate
(*a*) Unskilled ...	$ .80
(*b*) Semi-skilled ...	$ .85 to $ .94
(*c*) Skilled ...	$1.00 to $1.42
(*d*) Highly Skilled	$1.50 to $2.55
(*e*) Technicians ...	$1.85 to $3.57
(*f*) Supervisors ...	$ .11 per hour over the highest category within the Department they supervise.

Labour requirements in the operating sections of the Project have been segregated into three Groups, i.e.,

(*a*) Operating Labour

(*b*) Maintenance Labour

(*c*) Supervisory Labour.

Maintenance and Supply Budget cover both Operating and Maintenance Supplies (Mechanical and Electrical) oil, grease, saws knives, etc. Power Budgets cover the operating costs of the Project Power Generating Unit including wages, fuel and maintenance. It has been assumed that expatriate staff will be required to assist in training and supervision for the initial start-up of the production system. Allowance for this foreign expertise has been included in the operating and management sections.

Table 10.8—Pro-Forma Statement of Potential Profit and Loss (Before Interest and Depreciation) For Year 1-6 of Production

(M$ '000's)

	1	*2*	*3*	*4*	*5*	*6*
GROSS SALES	$4,620	$7,200	$7,200	$7,340	$7,480	$7,620
Deduct—Sales Commissions	228	360	360	367	374	381
Freight	257	368	368	384	400	416
Total	485	728	728	751	774	797
NET SALES	$4,135	$6,470	$6,472	$6,589	$6,706	$6,823
Cost of Logs	$1,250	$1,800	$1,800	$1,836	$1,872	$1,908
DIRECT OPERATION COSTS:						
Sawmill	407	636	604	620	635	650
Dry Kiln	151	131	134	139	144	148
Planer Moulding	226	298	255	260	267	274
Shipping	60	79	81	83	85	87
Steam	107	86	91	95	99	102
Total	$ 951	$1,230	$1,165	$1,197	$1,230	$1,261
Gross Profit	$1,934	$3,442	$3,507	$3,556	$3,604	$3,654
GENERAL AND ADMINISTRATIVE OVERHEADS:						
Management—Foreign	327	317	57	55	—	—
Local	54	54	57	59	60	62
Office Salaries	91	110	110	111	113	114
Supplies and General	47	52	54	56	58	60
Total	$ 519	$ 533	$ 278	$281	$ 231	$ 236
Division Operation Profit (Loss) Before Interest or Depreciation	$1,415	$2,909	$3,229	$3,275	$3,373	$3,418

11.0 APPENDIX F

11.0 SWAMP RESOURCE POTENTIAL—COMPONENT PARTS PLANT

Inventory analysis of the Bebar swamp (FMU. 1) indicates 177,000 acres with a specie mix consisting of 16 separate species in an acceptable colour and density range suitable for manufacturing. The manufacture of wood components is the most sophisticated development in the lumber industry in recent years. The further processing of sawn timber of a suitable colour, density, and grade into component parts produces sizeable increases in value as well as resultant employment.

A wood component manufacturing plant must be prepared to meet the rigid requirements of quality control and delivery schedules demanded by overseas markets. Growth in the wood components industry in the United States is directly proportional to increases in production in the furniture industry. The output of the furniture industry in the U.S.A. in 1975 is expected to reach $7.4 billion, an increase of 45% since 1969 level. Technological developments and environmental conditions, however, are rapidly changing manufacturing methods in the U.S. furniture industry. In the past, furniture manufacturers purchased rough lumber from which they produced each respective furniture part. Today, the most modern and profitable furniture plants are those devoted to assembly and merchandizing of furniture. Parts and sub assemblies are purchased in the same manner as in the automotive industry. The purchasing of parts from speciality woodworking plants closer to the sources of raw material has been found to be more practical and profitable to furniture manufacturers and merchandizers.

11.1 COMPONENT PARTS CATEGORIES

Component parts consist of three main categories, each holding the percentage share of the U.S.A. component market as indicated:

(*a*) Rough Components	21%
(*b*) Semi Machined Components ...	47%
(*c*) Fully Machined Components	32%
Total ...	100%

11.1.1 Rough Components

Rough components consist of blanks and squares, sawn and ripped to specific sizes and quality ranges. Squares are produced directly from sawn timber for end use in the turning industry. Blanks are produced from lumber and may be sold in rough or surfaced form; they are used extensively in upholstery and/or bending plants, and less frequently in case goods plants. Rough components are purchased to established specifications, rather than in lumber spades. These specifications, as agreed upon by the producer and the end user, will include the following:

- number of pieces
- size and specifications
- grade (clear, sound, etc.)
- species
- moisture content; e.g. green, air-dried, or kiln-dried.

Furniture companies will often resort to the use of rough components when they have a shortage of yard space, kiln drying capacity, or lack of capacity on their breakout lines. Rough components will frequently be purchased when a wood species other than that commonly used in the plant is required for a specific order.

11.1.2 Semi-Finished Components

Semi-finished components are produced both as solid members and as glued-up panels. Solid members consist of such items as mouldings, structural and frame parts, while glued panels are used mainly as tops, gables, chair seats, and drawer fronts, sides and backs.

These products are usually manufactured from kiln-dried lumber, at 6-8% moisture content. Further manufacturing generally involves one or more machining functions such as edge-gluing, moulding, tenoning, equalizing and trimming. A very important aspect of semi-finished components is that all waste materials such as knots, checks and decay have been removed, and in most cases, these components will enter directly into the manufacturing stream of the user-plant.

11.1.3 Fully Machined Components

There is a marked trend among American furniture manufacturers toward the use of fully machined wood components. In comparison to previous customs of the furniture industry the present trends indicate the fact that the use of fully machined components is increasing rapidly in the wood industry, furniture industry, and this, at the expense of the rough and semi-finished components markets.

Fully machined components are those parts which have gone through the complete cycle of machining operations and are ready for assembly, with the possible exception of a light, final sanding operation which is carried out in the user-plant. These components are very often purchased ready for assembly, in complete sets of parts required for a particular piece of furniture; such sets being referred to as "knocked-down furniture".

All such components must be manufactured according to very detailed specifications and very strict tolerances with regard to quantity, finished sizes, species, colour and grades, and it is a "fact of life" in this business that the inspection of incoming components by user-plants is carried out to much more rigid standards than would be the case if the components had been manufactured by the user-plant.

There is a definite trend in the United States towards specialization by wood components manufacturers, and as a rule, plants will not supply the full range of components used in the industry. For example, one firm will specialize in supplying quality hardwood cut stock for wood turnings and cut-to-size pieces for case goods, tables, chairs and home entertainment furniture; another firm will specialize in low quality hardwoods cut-to-size for upholstery frames; a third may specialize in cut-to-size softwoods for low quality upholstery frames and structural members in case goods. A sub-assembler, in most instances is even more specialized, as he will assemble parts for one specific product category; he may be a framemaker for upholstery manufacturers, or an assembler of drawers for unfinished case goods.

A noticeable trend in the upholstery industry is the use of knocked-down, fully-doweled furniture components. Upholstery furniture plants will bank a storage of knocked-down parts to be assembled later as required by production schedules. These speciality frame parts manufacturers purchase lumber on the open market, or buy cut-to-size blanks from which waste material has been removed.

11.1.4 **Standard Proprietary Items**

Standard proprietary items are found throughout the entire United States furniture industry. Such items are drawer sides and backs, bendings, trim woods, sub-assemblies for Colonial upholstered furniture, knobs, and appliques. These products are in most cases carried by major distributors who visit furniture plants on a continual basis, and furniture manufacturers will incorporate these standard items into their designs. Components of this type are manufactured by highly specialized plants and the market for such products is being penetrated by many countries such as Japan, Taiwan, Yugoslavia and Sweden.

11.2 MANUFACTURING REQUIREMENTS

Furniture manufacturing plants in the United States who purchase wood components will generally do business only with well-established components plants or new plants with a reputation and potential for supplying a high quality product manufactured to specific tolerances, and for meeting delivery schedules. In many cases the potential buyer will insist on visiting a components plant before placing an order with it so as to have first-hand knowledge of its capabilities and its staff and workers abilities.

11.2.1 **Description of Facilities and Operating Systems**

The plant would be situated on approximately 15 acres of land on the coast north of Kuala Rompin.

The system would utilize approximately 1,800,000 cu. ft. (36,000 T—50 cu. ft.) of raw material and consist of mainly:

(*a*) Sawmill

(*b*) Pre-dry and Dry Kilns

(*c*) Dimension Stock Plant

(*d*) Machining Stock Plant.

11.2.1.1 Sawmill

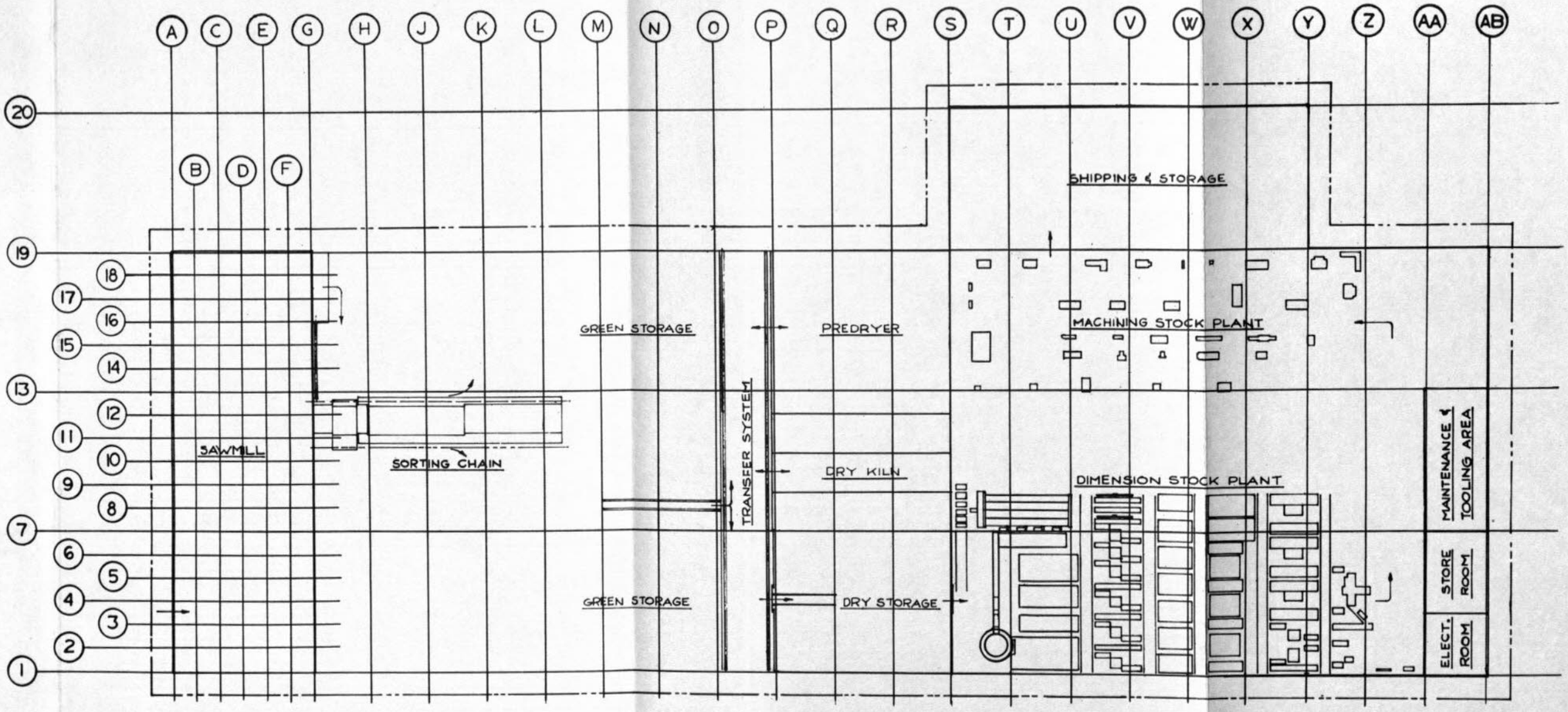
The sawmill would be similar in capacity and design to the proposed "Special Complex" operation.

11.2.1.2 Pre-dry and Dry Kilns

The Pre-Dry and Kilns would also be similar to the "Special Complex" operation but would also include dry storage area.

11.2.1.3 Dimension Stock Plant

The Dimension Stock Plant would take sawn timber from the dry storage area for the first stage of remanufacture. This plant, similar to the rest of the component part plant will be humidity controlled.



KAJIAN PERANCHANGAN KAWA

PAHANG TENGGA

REGIONAL MASTERPLANNING ST

For THE GOVERNMENT OF MALAYS
THE STATE GOVERNMENT OF PAH

LANJUT COMPLEX

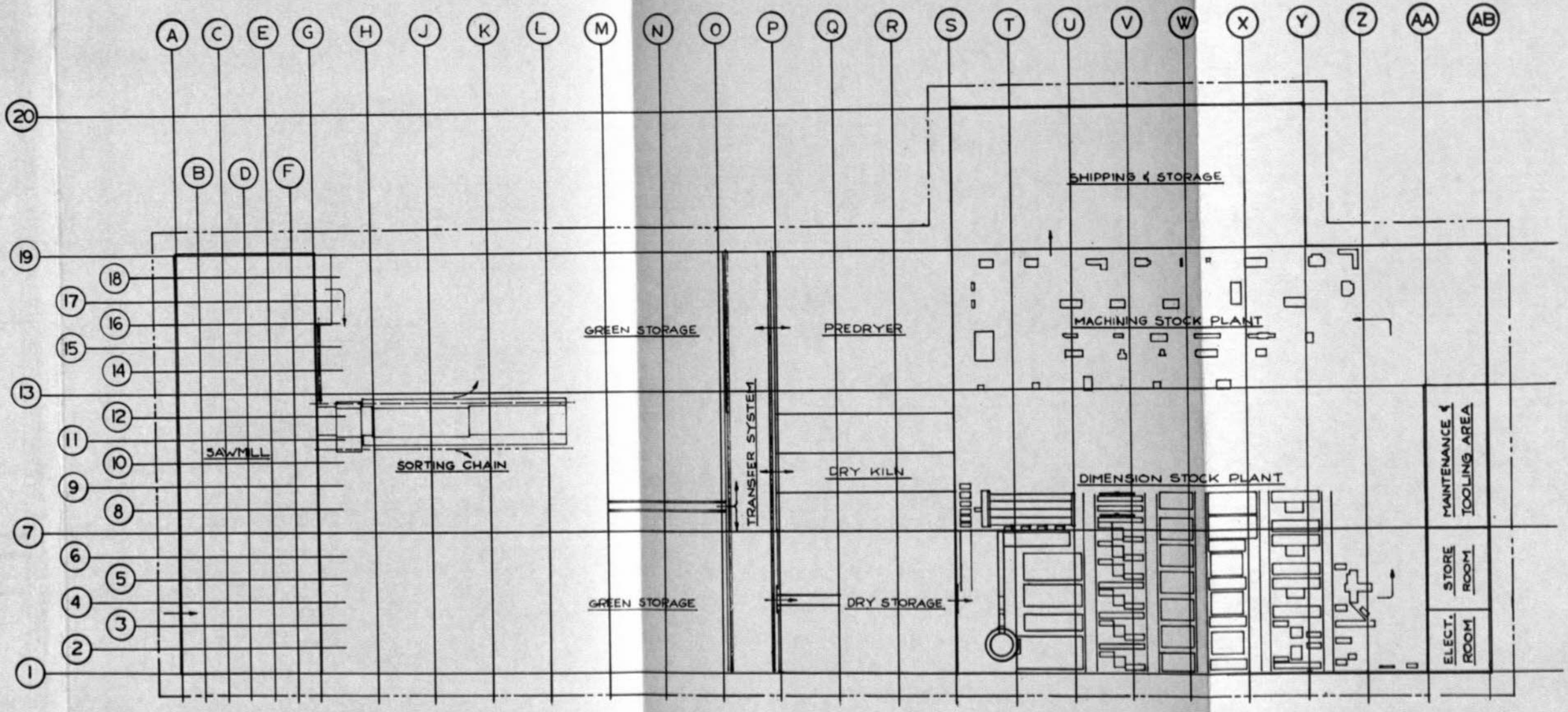
PRODUCT FLOW

COMPONENT PART PL

Planning Consortium Member
FENCO • ECOS • GARDINER • CHAR

SCALE	DATE
1"=30'-0	APRIL 13,

Fig. 11.2a



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LANJUT COMPLEX

PRODUCT FLOW

COMPONENT PART PLANT

Planning Consortium Member

FENCO • ECOS • GARDINER • CHARNELL

SCALE	DATE
1"=30'-0	APRIL 13,1972

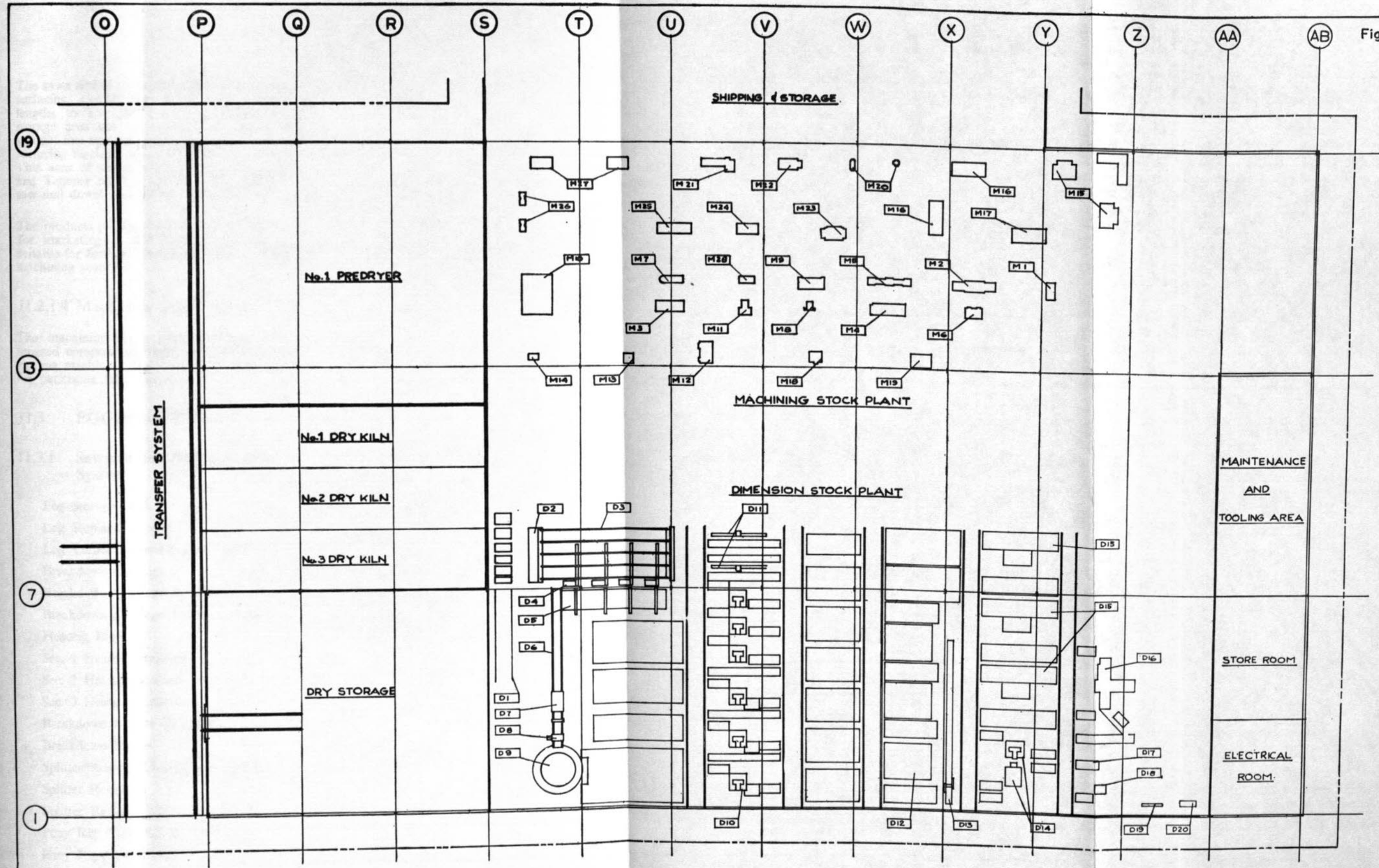

Fig. 11.2b

ITEM No.	EQUIPMENT
M21.01	BANDSAW
M21.02	PROFILE SHAPER
M21.03	EDGE & REBATE SANDER
M21.04	VERTICAL GANG BORER
M21.05	DOUBLE END BORING MACHINE
M21.06	DOUBLE SPINDLE SHAPER
M21.07	OSCILLATING EDGE BELT SANDER
M21.08	VERTICAL HOLLOW CHISEL MORTISER
M21.09	FRONT & BACK POST BORER
M21.10	SUPPRESSION PAD BELT SANDER
M21.11	HEAVY DUTY ROUTER
M21.12	VERTICAL TOP BELT SANDER
M21.13	CONTOUR SANDER
M21.14	SCROLL SANDER
M21.15	SHAPING LATHES
M21.16	BACK KNIFE LATHES
M21.17	COPYING LATHE
M21.18	TILTING VARIETY SAW & TABLE
M21.19	CHUCKING MACHINE
M21.20	MULTI DRILL PRESS
M21.21	AUTOMATIC TURNING SANDER
M21.22	AUTOMATIC SANDER
M21.23	SADDLE SEAT MACHINE
M21.24	SADDLE SEAT SANDER
M21.25	MULTI PURPOSE BELT SANDER
M21.26	DRUM SANDERS
M21.27	DOUBLE END DRUM BELT SANDERS
M21.28	SEMI AUTOMATIC DOVETAILER
D20.01	ROLLCASE INFEED
D20.02	TILT HOIST
D20.03	TRANSFER CHAIN
D20.04	CUT OFF SAW ASSEMBLY (4)
D20.05	No. 1 BELT CONVEYOR
D20.06	No. 2 BELT CONVEYOR
D20.07	FACING PLANER
D20.08	ROUGHING PLANER
D20.09	SORTING TABLE
D20.10	STRAIGHT LINE RIP SAWS (6)
D20.11	DEFECT SAWS (2)
D20.12	REVOLVING GLUE CLAMPS (3)
D20.13	EDGE GLUING ASSEMBLY
D20.14	PLANERS (2)
D20.15	MOULDERS (3)
D20.16	DOUBLE END TENNONER
D20.17	BAND RESAW
D20.18	DOWEL MACHINE
D20.19	DOWEL PIN CUTTER
D20.20	VARIETY LATHE

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LANJUT COMPLEX

EQUIPMENT LAYOUT

COMPONENT PART PLANT

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SCALE 1/8"=1'-0" | DATE APRIL 13, 1972

The sawn timber passes through the trimming and surfacing section for cut-up into production lengths to suit the cutting programme. From storage area the cut stock passes through the straight line rips into a glue clamp, moulding and surfacing machine area for further remanufacture. This area of the system also includes a double and Tenoner machine along with a recovery re-saw and dowel making operations.

The products produced up to this stage are ready for marketing as semi-finished components or suitable for further machining, and sanding in the machining section.

11.2.1.4 Machining Stock Plant

The machining stock plant will receive semi-finished components which will proceed through various machining and sanding operations ready for packaging for shipment.

11.3 EQUIPMENT LISTS

11.3.1 **Sawmill and Refuse Control System**

Log Storage Deck
Log Stop and Loader
Log Turner Assembly and Nigger
Breakdown Carriage
Breakdown Carriage Feedworks
Breakdown Carriage Tracks and Sheave
Headrig Bandmill
Sec. 1 Headrig Rollcase
Sec. 2 Headrig Rollcase
Sec. 3 Headrig Rollcase
Breakdown Resaw Cant Deck
Breakdown Resaw
Splitter Resaw Infeed Storage Deck
Splitter Resaw
Splitter Resaw Outfeed Belt
Pony Rig Jump Chain Transfer
Pony Rig Cant Storage Deck
Pony Rig Loader Assembly
Pony Rig Carriage
Pony Rig Feedworks
Pony Rig Tracks and Sheave
Pony Rig Bandmill
Sec. 1 Pony Rig Rollcase
Sec. 2 Pony Rig Rollcase
Pony Rig Transfer to Edger
Head Rig Transfer to Edger
Edger Infeed Rollcase
Edger
Edger Outfeed Rollcase
Accumulation Table
Grading Table
Sort Gate
Hula Trim Saw Assembly
Belt Conveyor to Green Chain
Treating Tank Infeed Transfer
Treating Tank
Green Chain Crowder Transfer
Sec. 1 Green Chain
Sec. 2 Green Chain
Filing Room Equipment
Air Compressor
Saws
M.C.C. and Controls
Air System Component
Main Mill Conveyor
Main Burner Conveyor
Burner Assembly
Slasher Assembly
Pony Rig Conveyor
Trimmer Conveyor
Edger Conveyor
M.C.C. and Controls
Hog Conveyor
Hog Assembly
Fuel Storage Conveyor

Total Budget Estimate: $1,384,000

Estimated Connected Horsepower: 1,125 H.P.

11.3.2 Pre-Dry and Kiln Systems

6 Line—86′ Pre Dry
3 Single Stack 86′ Kilns
Lift Truck
Transfer Truck
Sample and Test Equipment
Doors
Rail
Main Steam Line
M.C.C. and Control
Total Budget Estimate: $293,600
Estimated Connected Horsepower: 120 H.P.

11.3.3 Material Handling

Lift Trucks
Straddle Trucks
Log Loaders (1)
Total Budget Estimate: $304,000

11.3.4 Steam Plant

Steam Plant Unit (10 to 12 lbs per hour)
Electric Panel
Piping and Steam Line
Feeder Conveyor
Total Budget Estimate: $304,000
Estimated Connected Horsepower: 45 H.P.

11.3.5 Dimension Stock Plant

Roll Case Infeed
Tilt Hoist
Transfer Chain
Cut of Saw Assembly (4)
No. 1 Belt Conveyor
No. 2 Belt Conveyor
Facing Planer
Roughing Table
Sorting Table
Straight Line Rip Saws (6)
Defect Saws (2)
Revolving Glue Clamps (3)
Edge Gluing Assembly
Planers (2)
Moulders (3)
Double End Turnover
Band Resaw
Dowell Machine
Dowell Pin Cutter
Variety Lathe ,
Storage and Transfer Rollers
Exhaust System
M.C.C. and Controls
Knives, Heads Saws and Tools
Hand Lift Carts
Lift Truck
Humidity Control Assembly
Waste Conveyors
Total Budget Estimate: $1,749,000
Estimated Connected Horsepower: 835 H.P.

11.3.6 Machining Stock Plant

Band Saw
Profile Shaper
Edge and Rebate Sander
Vertical Gang Borer
Double End Boring Machine
Double Spindle Shaper
Oscillating Edge Belt Sander
Vertical Hollow Chisel Mortiser
Front and Back Post Borer
Suppression Pad Belt Sander
Heavy Duty Router
Vertical Top Belt Sander
Contour Sander
Scroll Sander
Shaping Lathes
Back Knife Lathes
Copying Lathe
Tilting Variety Saws and Table

Chucking Machine
Multi Drill Press
Automatic Turning Sander
Automatic Sander
Saddle Seat Machine
Saddle Seat Sander
Multi Purpose Belt Sander
Drum Sanders
Double End Drum Belt Sanders
Semi Automatic Dovetailer
Exhaust System
Air System
Knives Head Saws and Tools
Hand Lift Carts
Humidity Control Assembly
M.C.C. and Controls

Total Budget Estimate: $1,469,000

Estimated Connected Horsepower: 588 H.P.

11.3.7 Maintenance and Tooling Section

Universal Tool and Cutter Grinder
Knife Setting and Marking Unit
Balance Scales
Automatic Saw Sharpener
Saw Setting Machine
Carbide Saw Grinder
Jointer and Set Up Stand
Profile Cutter Grinder
Shaping Machine
Utility Lathe
Milling Machine
Metal Cutting Band Saw
Portable Hack Saw
Heavy Duty Grinder
Drill Press
Misc. Tools

Total Estimated Budget: $157,400

Estimated Connected Horsepower: 22 H.P.

11.3.8 Electric Power Generation

11.3.8.1 Power Requirements

Sawmill and Waste System	1,125 H.P.
Pre-Dry Kilns System ...	120 H.P.
Dimension Stock System	835 H.P.
Machining Stock System	588 H.P.
Maintenance Section ...	22 H.P.
Steam Plant	45 H.P.
Yard and Internal Light	200 H.P.
Total ...	2,935 H.P. (approx. 1,300 K.W.)

11.3.8.2 Power Generating Units

1	500 K.W.
2	330 K.W.
1	150 K.W.
Total ...	1,310 K.W.

Total Budget Estimate: $540,000

11.3.9 Summary—Budget Estimates—Equipment

Sawmill and Refuse Control System	$1,384,000
Pre-Dry and Kiln System ...	293,600
Material Handling System ...	304,000
Steam Plant	304,000
Dimension Stock Plant ...	1,749,000
Machining Stock Plant ...	1,469,000
Maintenance and Tooling Section	157,400
Electric Power Generation ...	540,000
Total Budget Estimate ...	$6,201,000
Freight and Handling	$937,000

11.4 OTHER BUDGETS

11.4.1 Site and Services

Site	15 acres

Site Preparation.
Culvert and Drainage.
Roads.
Water Supply.
Security Fencing.

Total Budget Estimate: $201,000

11.4.2 Buildings

Sawmill	15,550 sq. ft.
Green Storage	51,840 sq. ft.
Pre-Dry Kilns	12,780 sq. ft.
Dry Storage	6,500 sq. ft.
Dimension and Machining Stock Plant	58,320 sq. ft.
Shipping and Storage Area	12,900 sq. ft.
Steam Plant	12,000 sq. ft.
Miscellaneous Structures	4,000 sq. ft.
Total Area	173,800 sq. ft.

Total Budget Estimate: $1,520,000

11.4.3 Equipment Installation

Mechanical	$272,000
Electrical	286,000
Total Budget Estimate	$558,000

11.4.4 Project Engineering

Production flow and design and site, structural and general supervision.

Total Budget Estimate: $1,140,000

11.5 PROJECT SUMMARY

11.5.1 Project Budget

Area	*Local*	*Foreign*	*Total*
Equipment	$ 1,753,000	$ 4,448,000	$ 6,201,000
Freight and Handling	48,000	889,000	937,000
Site and Services	201,000	—	201,000
Buildings	1,520,000	—	1,520,000
Installation	558,000	—	558,000
Engineering and Disbursements	1,140,000	—	1,140,000
TOTAL	$ 5,220,000	$ 5,337,000	$10,557,000

11.5.2 Manning Tables

Manning Tables for each system have been segregated into skill classification covering the production systems and the Auxiliary Systems such as steam, electrical generation, maintenance, etc.

	Sawmill	*Pre Dry and Kiln*	*Dimensions Stock Plant*	*Machining Plant*	*Shipping*	*Auxiliary Operations*	*Admin.*	*Total*
Unskilled	8	—	40	12	12	—	4	76
Semi Skilled	23	8	42	22	18	—	3	116
Skilled	16	3	32	20	10	—	6	87
Highly Skilled	18	—	20	14	6	—	4	62
Technicians	—	—	20	22	4	30	8	84
Supervisors	2	2	5	10	3	6	3	31
TOTAL	67	13	159	100	53	36	28	456

11.6 OPERATION DETAILS

A fully finished component part plant is considered to be a sophisticated type of operation in the wood products industry and must be operated under rigid controls and accounting systems.

Theoretically, the ideal combination of knowhow, experience and resources to operate a profitable components plant is a joint venture involving an organization which has forest resources, and component part user. The former would provide an assured source of raw materials, while the latter would make available the knowledge and experience necessary to train new personnel and could also provide the required assistance at the managerial level. An added benefit of such a combination would accrue from the fact that the component part user could constitute a captive market for the less readily marketable components to be manufactured.

Historically, organizations whose main areas of expertise have been in the harvesting and sawmilling of lumber, who have branched into the manufacture of components have taken a long time in showing profits because of a lack of knowledge of the process and a lack of experience in managing a complex manufacturing operation. By the same token the particular talents, skills and experience required for lumber harvesting and sawmilling are not usually found among furniture manufacturers or component part users. Therefore, furniture plants integrating backwards into the manufacture of components have encountered problems of a very intricate nature in their attempts to enter the lumber harvesting and sawmilling industry.

As the many successful plants in the business today will bear out, diversification into the components industry does not present insurmountable hurdles, but the lack of knowledge of one or the other aspects of the business has caused many of these plants to go through long start-up periods during which heavy operating losses were sustained. It is, therefore, strongly recommended that any organization wishing to enter the field of components make the necessary arrangements to obtain the knowledge or expertise which it lacks to put a new plant into a profitable position in the shortest possible period of time.

11.6.1 Sales Considerations

One of the most critical factors in getting a new components plant rapidly out of the start-up period and into a profitable position is the ability of the sales force to obtain from the very start, such orders as to use all lengths of stock which develop from the breakout process, in the proper mixture of solid and glued-up components. A component plant cannot survive by selling only six foot solid rail and markets must be developed for shorts and for glued-up panels in order to keep waste factors to a minimum.

The optimum product mix and maximum yield in a component plant can be achieved by supplying a broad range of components to a number of different industries. A components manufacturer's marketing programme should, therefore, not be confined to a particular region's furniture industry, as the kitchen cabinet, mobile home and other wood components using industries will represent prime outlets for the plant's production.

With respect to the number of species used in the manufacturing process segregation for colour and density is a prime requisite and if possible be kept to four colours and density ranges when dried to 6-8% moisture content. It becomes very difficult to plan sales and schedule production with a large range of colours and densities.

Furniture styles dictate the species to be used. Early American styles which account for over 25% of furniture manufactured can be produced from species similar to maple, cherry, yellow birch, pine and red alder or be capable of staining to look similar. The Mediterranean and Spanish styles can be manufactured from high grain, dark species, similar to hickory, pecan, elm and oak. Walnut substitute can be used extensively in all styles, especially Modern, but is not used in Early American furniture.

The manufacture of wood components requires the removal of defects from lumber and the precision machining necessary to arrive at the specifications demanded by the industry. These functions within the industry are regulated by the quality control standards agreed upon between the producers and end users. The inability of a producer of wood components to manufacture to the agreed quality standards can be extremely costly after lumber has been increased to five times its original value. An axiom of the wood components industry is "Zero Defects".

Quality control programmes must be applied throughout the entire manufacturing process from the sawmill through to final packaging. Refusal of a shipment can result in considerable loss to the manufacturer and properly applied quality control programmes are the only safeguard which will guarantee that products will be continuously manufactured to specifications.

11.6.2 Production Costs

It is of the utmost importance, from a control point of view, that cost centres be established, so that a proper selling price for various articles to be manufactured can be arrived at.

These cost centres could be as follows:

1. The cost of logs delivered to the sawmill yard.
2. The cost of sawn lumber piled on stackers and delivered to the pre-dry and dry kilns.
3. The cost of dried lumber delivered to the Dimension Stock Plant.
4. The cost of semi-finished components delivered to the machining plant.
5. The cost of finished components ready for export.

Each section would be considered as a separate unit with pre-determined selling prices to the other units and it will be the responsibility of each unit to produce profitable results.

In other words, after proper detail studies, it would be determined the price of logs delivered to the sawmill and it will be up to the logging operation to deliver logs to the sawmill at a set price, which will enable them to make a profit. Similarly, it will be up to the sawmill to deliver boards to the dry kiln operation at a set price which will enable them to make a profit. Dried boards will then be delivered to the Dimension Stock Plant and Machining Plant at a pre-determined price per ton (50 cu. ft), and this price will be used on the cost sheets.

To achieve these results, it will be necessary to give all direct labour, indirect labour, factory expenses and administrative charges separate cost to allocate certain charges or plant burden which cannot be separated to various cost centres. Eventually, all these profit and loss figures for the various cost centres will be grouped in one major profit and loss statement for the whole organization. To do this properly, it will be necessary to build the proper budgets for each unit, and these budgets will contain such items as are usually considered in normal manufacturing operations.

11.6.3 Economic Feasibility

Log costs delivered to the mill yard have been estimated at $60 per ton (50 cu. ft round wood).

Labour costs have been estimated on the basis of $.80 per hour plus 12% fringe benefit.

The net sales price has been estimated on a rough measurement basis which allows for approximately 35% volume loss in the Dimension and Machining Plants. Average sales price used is $512 per T. F.O.B. Ship, based on 20,000 T. rough measure.

As an example of the potential profitability of a well operated component plant, a simple profit and loss statement that could be possible for the complex in question follows.

Table 11.6a—Profit or Loss Statement (Example)

Net Sales—20,000 T. @ $512/T. F.O.B. ...	100.0%	$10,240,000
Direct Cost (Table 11.6*b*)	48.5%	4,966,000
Factory Expenses (Table 11.6*c*)	11.6%	1,187,000
TOTAL MANUFACTURING COST	60.1%	$ 6,153,000
GROSS PROFIT	39.9%	4,086,000
Administration, and Sales Cost (Table 11.6*d*)	14.8%	1,516,000
ESTIMATED PROFIT BEFORE DEPRECIATION AND INTEREST	25.1%	$ 2,570,000

Table 11.6b—Direct Cost

A — RAW MATERIAL:	
Lumber	29.5%
Hardware	5.4%
Finishing Material	3.0%
Shipping Material	2.9%
Glue	.6%
	41.4%
B — DIRECT LABOUR	7.1%
TOTAL DIRECT COST	48.5%

Table 11.6c—Factory Expenses

A — DIRECT LABOUR	5.0%
B — MILL EXPENSES:	
Repairs and Maintenance ...	3.7%
Power	.5%
Fuel and Oil	.1%
Truck Expenses	.1%
Fire Insurance	.3%
Taxes	.5%
Fringe Benefits	1.4%
	6.6%
TOTAL FACTORY EXPENSES ...	11.6%

Table 11.6d—Administration and Sales Cost

A — ADMINISTRATION EXPENSES:	
Salaries	2.6%
Pension Plan	.7%
Bank Charges and Interest ...	.9%
Professional Fees	1.7%
Office Expenses	.4%
Stamps, telephone, telegrams ...	.4%
Travelling and car expenses ...	.6%
Office equipment location ...	.4%
Association memberships ...	.1%
Donations	.2%
	8.0%
B — SALES EXPENSES:	
Sales commissions	5.0%
Sales promotion	.9%
Transport on sales (F.O.B.) ...	.9%
	6.8%
TOTAL ADMINISTRATION AND EXPENSES	14.8%

12.0 APPENDIX G

12.0 PLYWOOD—STUDY RESEARCH[1]

32 logs of various species were obtained (Table 12.0) for the plywood testing programme. All trials were performed at the Forest Research Institute in Kepong, to obtain supplementary data on the potential of tree species in Pahang Tenggara to be utilised in commercial plywood manufacturing.

12.1 PEELING

Three thicknesses of veneer 0.050″, 0.100″ and 0.150″ were peeled from cold (not conditioned) of each species. Peeling was conducted at as high a speed as possible commensurate with veneer stacking. Where difficulties were encountered with non-conditioned logs, a 24 hour steaming at 35-40 psig. (approximately 140°C) preceded a second peeling experiment for similar veneer thicknesses. An analysis of initial peeling experiment is given in (Table 12.1).

[1] Study Report No. 4 "Plywood".

12.2 DRYING

Veneer was dried in the Schilde AG commercial veneer dryer which was recently put into service. Drying times were obtained for each species at each thickness. It was operated at 135 psig. steam pressure and produced a temperature of approximately 165°C. Where similar veneer thicknesses were obtained from sapwood and heartwood of a single species, drying schedules were determined independently. The actual dryness of the veneer was obtained using an Electronic Moisture Register. This instrument, which automatically relates conductivity to moisture content, requires specific calibration for each species, and this correlation was prepared prior to drying the bulk of veneer. Drying performance is tabulated (Table 12.2).

12.3 PLYWOOD PANEL PREPARATION

The following plywood constructions have been prepared following drying of each species of veneers.

	Face/Back	Cores	Centres	Total Thickness
3—ply	0.050″ ..	0.150″ ..	— ..	0.250″
5—ply	0.050″ ..	0.150″ ..	0.100″ ..	0.500″
7—ply	0.050″ ..	0.150″ ..	0.100″ ..	0.750″

Phebolic adhesive, mixed according to the resin manufacturer's recommendations, is spread on the veneer cores using the Schubert glue spreader fitted with rubber rolls. This spreader provides adjustment for adhesive application through the "doctoring" accomplished by the top and bottom roller glue trays. The application of adhesive is measured by weight difference of a core of known area passing between the rollers and converting this to pounds per thousand square feet of double glue line (lb/mdgl). The distribution between tight and loose sides of the core is determined and balanced by inserting three pieces of face stock in sandwich form, to provide similar thickness to core stock, then determining the weight pick-up on the outer veneers independently, and converting the figure to pounds per thousand square feet of single glue-line (lb/mdgl). The spreads used are those recommended by the adhesive manufacturer. Assembly times of 3 to 20 minutes were used and pressing times of 3½-7, and 9 minutes at 280°F were used for the ¼″, ½″ and ¾″ panels respectively, again according to the manufacturer's recommendations.

Further testing on soaking knife tests dry and wet shear tests and bonding tests were completed. (Table 12.3a and b).

12.4 CONCLUSIONS

It is concluded that the experimental results were sufficiently promising to indicate that those species tested could be employed in commercial plywood factories.

Further peeling and pressing experiments are undoubtedly necessary to optimise operational conditions but it appears that good bonding is possible so that less attractive or less desirable veneers might be grouped to serve satisfactorily.

It is recommended that further studies on plywood panel preparation utilizing more dense hardwoods covering assembly times, bonding characteristics and pressing times be carried out by either Forest Research Institute staff or outside consultants working in close harmony with Forest Research Institute staff.

Table 12.0—Logs Received at F.R.I. for Plywood Trials

Date Received	*Identification as Received*	*Confirmed Identification of F.R.I. Wood Anatomist*	*Comments on Log Condition*
19-2-71	Kelat	Kelat	4 ft. splits each end of 16 ft. log
"	Perah	Perah	End checked
"	Seraya	Seraya	No expmts. run with this species
"	Keranji	Keranji	Some end checks
"	Nemesu	Nemesu	Some end checks
"	Petaling	Kamap	Some end checks
"	Mempisang	Mempisang	Some checks
"	Mata Ulat	Casearia flexula	End checks
"	Minyak Berok	Minyak Berok	End checks
"	Berangan	Mempening	No expmts. with this log (4 ft. splits each end)
"	Mempening	Mempening	Some end checks
18-8-71	Mata Ulat	—	Large 3 ft. diam.
"	Mata Ulat	—	Large 32" diam.
"	Kedondong	—	No expmts. with this log
"	Berangan	—	No expmts. with this log
"	Perah	—	No expmts. with this log
"	Keruing	—	No expmts with this log
14-9-71	Mempisang	Kembang Semangkok	
"	Mempisang	Symlocos sp.	
"	Ara berteh	Ara berteh	First priority in this series
"	Mempisang	Kembang Semangkok	
"	Perah	Perah	
"	Kelat	Penaga	
"	Perah	Perah	
"	Kelat	Kelat	
"	Mempisang	Kembang Semangkok	
"	Kelat	Kedondong	
"	Petaling	Petaling	
"	Minyak Berok	Minyak Berok	
"	Ara Berteh	Ara Berteh	
"	Kelat	Kelat	First priority in this series
"	?	Kembang Semangkok	

Table 12.1—Peeling Performance of Minor Species

Confirmed Identity	*Pre-Conditioning*	*Comments*	*Performance*
Nemesu	Cold	Initial billet slipped in 4″ chuck, but held in 6″ chuck. Veneer smooth. No problem at any thickness	A-B
Mempening	Cold	Numerous splits in veneer, partly from splits in the billet, but the veneer itself also split readily. Veneer was brash	C
Mempisang	Cold	Quite a smooth veneer obtained with few splits at any thickness	A-B
Kelat	Cold	Smooth veneer at all thickness. No problem	A-B
Casearia flexula	Steamed	Very dense wood. Lathe knife sustained nicks and separation along joint of cutting steel to balance of knife. Good veneer in spite of this problem	B
Minyak Berok	Steamed	Dense wood providing strong but brittle veneer. Considerable experimentation with lathe and knives is indicated if this species is to be commonly used	C-D
Mata Ulat	Cold	Dense wood providing brittle veneer. Splitting of veneer limits its usefulness to cores and centres, or concrete form work	C-D
Mata Ulat	Steamed	Noticeable improvement over cold-peeled veneer, but still brittle and checking	C
Perah	Steamed (156°C)	Extremely difficult to peel without pre-heating. Only slightly less difficult after pre-hearing	D
Kamap	Steamed (156°C)	Easy to slightly difficult to peel	B-C
Keranji	Steamed (156°C)	Easy to slightly difficult to peel	B-C

PERFORMANCE RATINGS

A = Excellent.
B = Good.
C = Fair.
D = Poor.

Table 12.2—Drying Performance of Minor Species

Common Name	Botanical Name	Thickness	Type (Heart or Sap.)	Drying Time	Moisture Meter Reading Ave/Range	% Moisture Meter Reading Ave/Range	Remarks	% Shrink
Kelat	Eugenia sysygioides	0.050	Heart and Sapwood	7.4	11.9/10.-13	1.6/1.2-2.1	Overdry	5.7
		0.100	Heart and Sapwood	11.5	-/10.-14	3.1/1.0-7.4	H. & S separation would improve quality	—
		0.150	Heart	16.7	11.8/12-13	-/1.0-1.7	Overdry	5.6
	Casearia flexula	0.050	Heart	4.5	-/9.5-11	1.5/0.5-2.0	Overdry	8.2
		0.100	Heart	7.5		3.7/2.2-5.0	Satisfactory	7.6
		0.150	Heart and Sapwood	12.0	-/6.5-8	2.5/1.7-3.0	Dried at 8.5" and re-dried at 3.5"	5.6
Minyak Berok ..	Xanthophyllum verrucosum ..	0.050	Heart	4.5	-/7.5-12	2.4/2.2-2.6	Overdry	8.4
		0.100	Heart and Sapwood	8.7	10.0/8.5-11	5.9/4.9-7.0	Small amount sapwood included	7.3
		0.150	Heart	12.7	-/6.5-8.5	1.6/1.0-1.9	Overdry	8.5
Perah	Elateriospermum tapos ..	0.05	Sapwood	3.8		1.4/ .9-1.9	Overdry	5.3
		0.10	Sapwood	9.1		3.1/3.0-3.3	Slightly low	—
		0.10	Sapwood	7.0		1.6/1.2-1.9	Overdry	—
		0.15	Sapwood	19.8		1.8/1.6-2.3	Overdry	6.9
		0.15	Heartwood ..	16.8		5.1/4.8-5.5	Satisfactory	4.
Kamap	Strombosia rotundifolia ..	0.05	Sapwood and Heart	12.2		4.6/3.9-5.2	Satisfactory	8.1
		0.10	Sapwood and Heart	15.7		5.1/4.4-5.8 4.4/3.7-5.0	Satisfactory Satisfactory	7.4
Nemesu ..	Shorea pauciflora	0.050	Heart and Sapwood	5.7	6.7/6.3-7.0	6.8/4.4-8.7 15.7/15.5-17.0	Slightly high Sap portion high moisture	7.9
		0.100	Heart	8.8	-/15.0-19.5	6.0/5.9-7.5		
			Sapwood	20.0	8/-	3.0/-	Sapwood overdried ..	—
		0.150	Heart	13.5	15.7/14.0-17.5	5.7/5.2-7.1		
			Sapwood	22.5	8.1/-	3.0/-	Sapwood overdried ..	—
Mempisang ..	Monocarpia marginalis ..	0.050	Heart	2.9-4.0		4.3/3.7-4.7	Good veneer	—
		0.100	Heart	8.3		2.9/2.7-3.1	Overdry	—
		0.150	Heart and Sapwood	12.8-16	-/6.-18.5	-/3.-11	Sap portion High MC	—
Mempening ..	Overcus lamponga	0.050	Heart and Sapwood	5-7.2		3.0/2.0-3.6	Slightly over dried ..	—
		0.100	Heart and Sapwood	9-19		-/1.0-12.0	H. & S. should be separated	—
		0.150	Heart and Sapwood	18-21.5	-/9.-15.	-/2.0-8.0	H & S should be separated	—
		0.15	Sapwood and Heart	21.5		4.7/3.4-5.4	Satisfactory	7.6
Keranji	Dialium spp.	0.05	Sapwood and Heart	6.4		7.9/3.6-10.5	Slightly high	—
		0.10	Sapwood and Heart	12.		1.7/1.5-1.8	Overdry	8.1
						3.4/2.8-3.9	Slightly low	7.5
		0.15	Sapwood and Heart	18.4		4.0/3.9-4.5	Satisfactory	7.3
						4.4/4.1-4.9	Satisfactory	7.3
						9.2/8.6-9.7	Somewhat high ..	6.7

Table 12.3a—Phenolic[1] Bonded Plywood

Species	Construction	Spread lb/MDGL	ASSEMBLY TIME		Pressing[2] Time	Average Compression %	Knife Test	Shear Test (lb)	% Of Wood Failure
			Open	Closed					
Mempening	3-ply	90	0.25	7	3	3.9	3.3 dry	82 dry	19
	3-ply	90	0.25	8	3		0.6 wet	delam	—
	5-ply	90	0.5	13	7	9.1	4.2 dry	—	
	5-ply	90	0.5	13	7		1.0 wet	—	
	7-ply	90	2.0	18	9½	6.2	4.7 dry	—	
	7-ply	90	2.0	17	9½		1.9 wet	—	
Mempisang	3-ply	90	0.25	7	3	6.1	8.3 dry	117 dry	77
	3-ply	90	0.25	7	3		8.8 wet	100 wet	90
	5-ply	90	0.5	14	7	4.8	8.3 dry	—	
	5-ply	90	0.5	15	7		8.2 wet	—	
	7-ply	90	2.0	19	9½	4.2	8.1 dry	—	
	7-ply	90	2.0	19	9½		7.5 wet	—	
Nemesu	3-ply	90	0.25	1	3	4.4	7.0 dry	86 dry	77
	3-ply	90	0.25	4	3		5.8 wet	70 wet	78
	5-ply	90	0.5	8	7	5.0	7.4 dry	—	
	5-ply	90	0.5	12	7		6.3 wet	—	
	7-ply	90	2.0	12	9½	4.7	7.7 dry	—	
	7-ply	90	2.0	14	9½		6.1 wet	—	
Perah *Elateriospermum tapos*	3-ply	(92-96)							
	3-ply	(92-96)	0.25	4	3½	4.55	5.1 dry	142 dry	60
	3-ply	(92-96)	0.25	7	3½		3.3 wet	92 wet	58
	5-ply	(92-96)	0.5	4	7	5.95	5.9 dry	—	
	5-ply	(92-96)	0.5	15	7		5.2 wet	—	
	7-ply	(92-96)	2.0	13	9½	4.85	7 dry	—	
	7-ply	(92-96)	2.0	19	9½		4.3 wet	—	
Kamap *strombosia rotundifolia*	3-ply	(92-96)	0.25	6	3½	4.0	4.3 dry	161 dry	55
	3-ply	(92-96)	0.25	9	3½		3.0 wet	114 wet	46
	5-ply	(92-96)	0.5	17	7	4.2	5.1 dry	—	
	5-ply	(92-96)	0.5	16	7		1.5 wet	—	
	7-ply	(92-96)	2.0	19	9½	4.2	6.5 dry	—	
	7-ply	(92-96)	2.0	14	9½		3.8 wet	—	
Keranji *Diallium spp.*	3-ply	(92-96)	0.25	6	3½	6.3	4.5 dry	173 dry	44
	3-ply	(92-96)	0.25	7	3½		3.2 wet	121 wet	44
	5-ply	(92-96)	0.5	16	7	6.9	5.2 dry	—	
	5-ply	(92-96)	0.5	16	7		2.8 wet	—	
	7-ply	(92-96)	2.0	18	9½	4.6	5.6 dry	—	
	7-ply	(92-96)	2.0	22	9½		2.3 wet	—	

Table 12.3a—Phenolic[3] Bonded Plywood—(*cont.*)

Species	*Construction*	*Spread lb/MDGL*	*ASSEMBLY TIME*		*Pressing Time*	*Average Compression %*	*Knife Test*	*Shear Test (lb)*	*% Of Wood Failure*
			Open	*Closed*					
Kelat *Eugenia Syzygioides* ..	3-ply ..	88	0.25	3	3½	5.3	7 dry	159 dry	60
	3-ply ..	88	0.25	4	3½		5 wet	108 wet	33
	5-ply ..	88	0.5	12	7	5.8	8 dry	—	—
	5-ply ..	88	0.5	11	7		6 wet	—	—
	7-ply ..	88	2.0	15	9½	8.1	7 dry	—	—
	7-ply ..	88	2.0	19	9½		6 wet	—	—
Kelat *Casearia flexula*	3-ply ..	88	0.25	7	3½	5.7	8 dry	178 dry	78
	3-ply ..	88	0.25	11	3½		5 wet	128 wet	52
	5-ply ..	88	0.5	13	7	5.5	8 dry	—	—
	5-ply ..	88	0.5	14	7		7 wet	—	—
	7-ply ..	88	2.0	23	9½	4.5	7 dry	—	—
	7-ply ..	88	2.0	23	9½		5 wet	—	—
Minyak Berok *Xanthophyllum spp.*	3-ply ..	88	0.25	11	3½	1.6	6 dry	186 dry	82
	3-ply ..	88	0.25	16	3½		4 wet	138 wet	66
	5-ply ..	88	0.5	15	7	5.5	5 dry	—	—
	5-ply ..	88	0.5	15	7		7 wet	—	—
	7-ply ..	88	2.0	21	9½	3.5	5 dry	—	—
	7-ply ..	88	2.0	20	9½		6 wet	—	—

[1] Nemesu, Mempisang and Mempening glued with Cascophen PA2 & PXE4 filler (100 pts. resin & 40 pts filler) all others glued with Norphen 500 with 300 Hardener (100 pts. resin to 30 pts. filler).

[2] Pressing temperatures were 138-140°C, Pressure was only about 110 psi on Nemesu, Mempisang and Mempening, 200 psi on all others.

[3] W.B.P. = Weather and Boil proof, as specified in BS. 1455: 1963 (72 hr. boil test).

Table 12.3b—Urea[1] Bonded Plywood[2]

Species	Construction	Spread lb/MDGL	ASSEMBLY TIME		Pressing[3] Time	Average Compression %	Knife Test	Tension Shear	% Of Wood Failure
			Open	Closed					
Nemesu *Shorea pauciflora* ..	3-ply ..	60-68	0.25	6	5½	11.7	6 dry	190	68
							No specimen	—	—
	5-ply ..	60-68	0.50	7	7½	13.8	6 dry 2 MR		
	7-ply[4] ..	60-68	2.0	14	9	7.6	8 dry 4 MR		
Minyak Berok[5] *Xanthophyllum spp.*	3-ply ..	60-68	0.25	15	5½	10.3	4 dry	95	48
							No specimen	—	—
	5-ply ..	60-68	0.5	18	7½	5.1	4 dry 2 MR		
	7-ply[6] ..	60-68	2.0	18	9	3.7	3 dry 2 MR		

[1] Kaurit 285 adhesive with 500 hardener (100 pts. resin 7.5 pts. filler).

[2] Incomplete experiments were conducted with Casearia flexula and Kelat (Eugenia syzygioides) but their results held no significance for this report.

[3] All pressing were at 120°C and 285 psig.

[4] Cross bands were Casearia flexula, owing to shortage of veneer.

[5] Glue penetration was quite heavy.

[6] Cross bands were Perah, owing to shortage of veneer

13.0 APPENDIX H

13.0 PARTICLEBOARD—STUDY RESEARCH[1]

Particleboard is the general term applied to rigid panels prepared by a dry process in which comminuted wood or other ligno-cellulosic material is bonded with an organic resin adhesive under heat and pressure. (Flakeboard and chipboard describe more the nature of the sub-divided particles in certain particleboards).

Present day forest utilization practice involves considerably more than merely a sawmill or plywood operation, either of which uses only about 50 percent of the original log. Modern forest products complexes scavenge the residues from such operations and convert these to profitable products such as pulp, particleboard and fibreboard. The Scope of Work of the Pahang Tenggara Study specifically excludes pulp and paper studies since these were already actively underway at the Forest Research Institute at Kepong. Also, with a senior representative of the Institute involved in a technical study and training programme on fibreboard at the Tropical Products Institute, London, then any undertaking on fibreboard would be considered redundant.

The objective of this investigation then became to conduct a programme of experimental studies on particleboard, and to illustrate appropriate techniques and conditions suitable for its commercial manufacture in Malaysia using as furnish available slabs, edgings, peeler cores, veneer wastes and possible forest residues from projected integrated forest complexes in the Pahang Tenggara study region.

The particleboard industry is a relative late comer in the utilization of waste from lumbering and other forest industries. The process originated in Germany during the early 1940's and developed rapidly there and in other densely populated but sparsely forested European countries where it was able to meet the demand for a low cost building board. The growth of the industry has been spectacular. Today, there are more than 630 mills in 72 countries producing nearly 16,270 m^3 or 10,600,000 metric tons per year. Such growth as indicated was bound to develop technical interest in the process, and considerable improvements in the product have been made as a result of a great many studies.

[1] Study Report No. 5 "Particleboard".

13.1 MANUFACTURING CHARACTERISTICS

The general process of particleboard preparation involves sub-dividing the wastewood supply into comparatively uniform small particles, mixing these with 4-10 percent urea formaldehyde or phenol formaldehyde resin, then forming a mat which is pressed under conditions of high temperature which cure or set the resin.

Pressing temperatures and times are adjusted according to the resin type and panel thickness being prepared. Sizing and other additives may be added in order to inhibit swelling from moisture pick-up, to provide greater resistance to attack from termites and other insects, and to retard combustion.

The specific requirements for acceptability in different countries vary, however, general requirements of coreboard may be defined and they include the following characteristics in two of the more common grades.

Cabinet and Furniture Grade:

Good internal bond.

Good screw holding, both in-plane and perpendicular to the surface.

Uniform, smooth surface.

Low thickness swelling.

Good dimensional stability.

Construction Grade:

Good internal bond.

Good screw holding, particularly perpendicular to the surface.

Uniform, smooth surface.

Low thickness swelling.

Good dimensional stability.

Good bending resistance.

13.2 EXISTING INDUSTRY IN MALAYSIA

The particleboard industry of Malaysia consists of one small (9T/d) plant at Tampoi, Johore Bahru, operated by Malaysian Industrial and Engineering Company (MIECO). This factory started operations in 1961 and continued until late 1969 when it was closed down. It was re-opened early in

1970 under new management which in November was considering 3 shift operation and preparing plans for a new and larger mill to replace the present one. There is virtually no automation at this mill, the 3 layer panels are all formed by manual distribution of flakes, much like one does in a laboratory, then the mats are pressed in a two opening press. The mill purchases light hardwood trims, slabs and edgings in pre-cut lengths to suit its flaker, from local sawmills. The main species included are Geronggang, Terentang, Machang and Medang. Despite a complete lack of quality control, the panels appear to have found a ready market in Singapore and Malaysia.

The specific composition of the initial furnish (supplied by MIECO) was not known. The flakes were drawn from the dried flake storage area of the mill and are believed to be typical furnish for that operation.

13.3 TEST PROGRAMME

Until such time as the Industrie-Companie flaker arrived and was installed, planer shavings were obtained as available from the Timber Testing Section of the Forest Research Institute. It is, of course, well known that planer shavings do not make optimum quality particleboards, but this should not preclude their use in such situations as this one when they could serve to indicate potential gluability problems and the variability of different species.

The initial MIECO supplied flakes were dry, having a moisture content of only about 2%. Other flakes were dried in wire mesh trays in ovens until their moisture content was 6%. Several attempts were made to use wet or green chips with powdered phenolic adhesives during a period an oven was out of service. The Forest Research Institute large capacity oven was transferred and installed and was in regular use. Dried particles were stored in heavy walled polythene bags until required.

Both Urea-Formaldehyde and phenolic resin have been used. The U-F resin is a thick viscous resin supplied at 62% total solids. The phenolic resin used is a very fine powder.

The U.F. resin viscosity was lowered by diluting to 50% solids prior to spraying with a standard spray gun using 58-60 psig. air to ensure sufficiently fine spray to permit adequate flake coverage. The adhesive reservoir on the gun was calibrated volumetrically in order to provide a rapid measure of the application.

Phenol-formaldehyde powdered resin was used on panel 11-18 inclusive. The switch to P-F was made in an attempt to maintain progress in panel production when Forest Research Institute oven drying facilities were inoperative.

It was reasoned that the 100% solids of the resin might permit the use of higher moisture content flakes, and the excess moisture be driven off during the pressing period. The desired weight of resin powder was mixed with the flakes in a large polythene bag by inflating the bag with air, then shaking the mixture vigorously, so that the fine powder would adhere to the damp surfaces of the particles. This mixing method appeared to be quite effective.

Forming involved hand distribution of the sprayed flakes into a mould resting on a stainless steel caul. The surface of the caul is wax-coated in order to repel surface particles from sticking to it. As each layer is formed it is hand compacted with a board acting as a cylinder within the mould box. During the last compaction the mould-box is removed so that the mixture resting on the caul is free standing. Another pre-waxed caul is placed on top of the furnish and the composition is ready for pressing.

Pressing was conducted in an electrically heated thermostatically controlled hydraulic press. 160°F is used when pressing U-F boards, but 185°F is required to cure phenolics. Commercially, pressing is conducted to spacers (steps) in order to obtain the appropriate thickness across the whole board, but the use of steps in the small laboratory press did not appear practical, so pressing was conducted to pressures providing desired thicknesses.

The added requirement of bending resistance (stiffness) for the construction grade product may be most readily achieved by making a slightly thicker panel. Stiffness of a uniform material is proportional to the cube of its thickness. Other means of improving stiffness are available, particularly effective would be the overlay or "skin".

In the early stages of the programme the most significant tests were considered to be internal bond and screwholding ability. When adequate results were achieved with these tests, then attention was directed to such other tests as static bending.

13.3.3 **Internal Bond Test**

The internal bond test measures the force required in tension to pull apart 4 square inches of board. The test was conducted by glueing steel

plates to both faces of 2″×2″ sample with epoxy adhesive, then pulling the plates apart with a direct pull using a jig fitted to a universal compression-tension tester. The results are expressed as pounds per square inch, though other units may be used.

13.3.2 Screw Holding Test

The screw holding test is another A.S.T.M. procedure, this one for determining the force required to extract a standard screw in a standardized manner on a direct pull. A one inch No. 10 wood screw inserted 2/3 of an inch into a 7/64 inch lead hole was specified. To a certain extent this test appears to duplicate the Internal Bond test on a smaller area basis, however, the wood species and particle shape tend to have greater influence on this test result than on the I.B. The results are expressed directly in pounds.

13.3.3 Static Bending Test

Static bending test is a measure of the load-deflection curve, i.e. it provides answers to the question "How much lead will a panel support before it is likely to break?" The test is important where strength is required, as in construction or sub-flooring grades. From this one test four significant structural values can be calculated.

A. Modulus of Rupture

B. Stress at the proportional limit

C. Stiffness, or apparent Modulus of Elasticity

D. Work to maximum load.

Table 13.3a indicates the wood furnish of panels using various species. Table 13.3b is a screen analysis of flake bends.

The results of all tests on panels prepared are given in Table 13.3c, preliminary panels, Table 13.3d, single layer Panels from Mixed Species of Flaker Particles, Table 13.3e, Triple layer Panels from Mixed Species of Flaker Particles. Table 13.3f gives some comparative values of commercial particleboard samples tested locally with the same conditions employed as for experimental panels.

The production of particleboard by MIECO provides initial proof that Malaysian species are suitable for particleboard. It can be concluded from the studies undertaken using medium hardwood mixtures as core stock for three layer board that the sapwood from medium hardwoods also make acceptable furnish. Further studies would be necessary for optimising flaking conditions for specific grades. Other species of similar density, barring excessive resin contents, are similarly expected to produce a satisfactory particleboard product.

Table 13.3a—Wood Furnish Composition for Particleboard Panels

Mix	*Species*	*Percentage*	*Weighted Average O.D. %*	*Nominal Length (mm)*	*Nominal Thickness (mm)*
Light Hard Wood No. 1	Mempisang Seraya Nemesu	37.1 30.0 32.9	98.2	20	0.3
Light Hard Wood No. 2	Mempisang Seraya Nemesu	29.3 29.7 41.0	96.3	15	0.3
Medium Hard Wood No. 1	Mata Ulat Perah Berangan Mempening	28.6 23.4 20.8 27.2	91.7	20	0.3
Medium Hard Wood No. 2	Mata Ulat Perah Berangan Mempening	21.7 22.0 25.1 31.2	98.0	15	0.3
Medium Hard Wood No. 3	Mata Ulat Perah Berangan Mempening	27.1 21.4 17.4 34.1	99.1	15	0.8
Medium Hard Wood Mix No. 4	Mata Ulat Parah Berangan Mempening Keruing	21.5 17.0 13.9 27.1 20.5		15	0.8

Table 13.3b—Screen Analyses of Flake Bends

	+1/2″	+1/5″	+1/12″	+1/20″	−1/20″
LHW Mix No. 1 (20mm × 0.012″)	47.8	37.9	10.9	1.4	2.0
MHW Mix No. 1 (20mm × 0.012″)	5.3	72.0	13.2	3.1	6.4
LHW Mix No. 2 (15mm × 0.012″)	8.4	69.0	13.9	3.4	5.3
MHW (Mix No. 2 (15mm × 0.012″)	0.8	68.7	20.6	3.3	6.6
MHW Mix No. 3 (15mm × 0.030″)	8.1	57.9	30.1	2.3	1.6

Assuming the screens separate by width rather than any other dimension, and also assuming that the screen mesh provides a reasonable estimate of particle width then the average particle calculated width would be as shown below, using the combined weights of +1/20 and −1/20 for bottom range thickness. The surface areas have been calculated from the widths obtained.

Table 13.3c—Weighted Average Particle Sizes

	Width (mm)	Surface Area (cm^2)
Light Hardwood Mix No. 1 ...	8.3	3.5
Medium Hardwood Mix No. 1 ...	4.7	2.0
Light Hardwood Mix No. 2 ...	5.0	1.6
Medium Hardwood Mix No. 2 ...	4.2	1.4
Medium Hardwood Mix No. 3 ...	4.6	1.7

The individual particles in the panels will have narrower width and consequently smaller area due to fracturing with the grain during glue mixing. The less flexible medium hardwoods will be particularly affected in this manner.

Table 13.3d—Single Layer Panels From Mixed Species of Flaker Particles

Panel No.	Flake Source	Wght. and % of Bd.	% of Resin App'n	Pressing		Max. Panel	Caliper	Density	Testing	Screw Holding		Remarks
				Temp. C°	Time (min)	Pressure (psi)			Internal Bond (psi)	Face	Edge	
27	LWH Mix 1 ..	1,000 gms 100%	9.0	160	6	600	0.434	0.83	27			Pressing time and Pressure not recorded adequately
28		1,000 gms 100%	6.0		6	400	0.528	0.67	29			" " "
29		1,000 gms 100%	9.0	157	5	600	0.426	0.87	33			Breaks all occurred adjacent to scorched surface. Temp.?
30		1,000 gms 100%	6.0	159	5	600	0.428	0.84	44			
31		1,000 gms 100%	7.5	160	5	600	0.456	0.79	56			
32		1,000 gms 100%	5.0	160	5	600	0.458	0.78	44			
33		1,000 gms 100%	8.0	160	5	600	0.65	0.56	49			1st. bd. made using "stops"
34		1,060 gms 100%	8.0	159	5	600	0.64	0.60	63			
35		1,120 gms 100%	8.0	158	5	600	0.65	0.62	46			
36		1,180 gms 100%	8.0	157	5	600	0.67	0.63	59			
41		1,240 gms 100%	8.0	155	5	600	0.65	0.71	51			
37	MHW Mix 1 ..	1,060 gms 100%	9.0	158	5	600	0.62	0.64	?			Partial delamination attributed to high MG from high glue appl'n. If this had not happened then S.G. would be higher
38		1,060 gms 100%	6.0	158	5	600	0.64	0.59	29			
39		1,060 gms 100%	5.0	157	5	600	0.62	0.61	16			Glue spread inadequate, apparently
40		1,240 gms 100%	8.0	156	5	600	0.63	0.74	45			
42	LWH Mix 2 ..	1,240 gms 100%	9.0	159	5	600	0.63	0.73	58			
43		1,240 gms 100%	5.0	160	5	600	0.66	0.68	50			Pressure dropped at full press engagement from 1,500 psig. Subsequent bds. could only attain 1,100 and on ram gauge

Table 13.3d—Single Layer Panels From Mixed Species of Flaker Particles—(*cont.*)

Panel No.	*Flake Source*	*Wght. and % of Bd.*	*% of Resin App'n*	*Pressing*		*Max. Panel*	*Caliper*	*Density*	*Testing*	*Screw Holding*		*Remarks*
				Temp. C°	*Time (min)*	*Pressure (psi)*			*Internal Bond (psi)*	*Face*	*Edge*	
44	LWH Mix 2 ..	1,240 gms 100%	7.5	159	5	460	0.66	0.69	42			
45		1,240 gms 100%	6.0	159	5	460	0.66	0.69	39			
46	LWH Mix 1 ..	1,240 gms 100%	5.0	159	5	440	0.69	0.66	50			
47		1,240 gms 100%	6.0	159	5	440	0.69	0.67	52			
48		1,240 gms 100%	9.0	158	5	440	0.67	0.71	54			
52	MHW Mix 2 ..	1,240 gms 100%	9.0	157	5	480	0.63	0.71	35			
53		1,240 gms 100%	6.0	158	5	480	0.64	0.71	61			
54		1,240 gms 100%	5.0	159	5	480	0.63	0.69	52			
55		1,240 gms 100%	7.5	158	5	480	0.63	0.71	59			
63	MHW Mix 3 ..	1,240 gms 100%	6.0	157	5	480	0.63	0.69	41			
64		1,240 gms 100%	5.0	156	5	480	0.63	0.70	44			
65		1,240 gms 100%	7.5	156	5	480	0.63	0.71	39			
66		1,240 gms 100%	9.0	157	5	480	0.62	0.71	35			
85	Pitchy Keruing ..	1,240 gms 100%	9.0	155	5	500	0.60	0.77	65	276		
86	„ ..	1,240 gms 100%	6.0	153	5	500	0.61	0.74	47	235		
87	MHW Mix 4 ..	1,240 gms 100%	6.0	151	5	490	0.63	0.71	52			
88	„ ..	1,240 gms 100%	9.0	154	5	490	0.62	0.73	48			

Table 13.3e—Triple Layer Panels From Species of Flaker Particles

Panel No.	Face Stock: Flake Source	Face Stock: Wght. and % of Bd.	Face Stock: % of Resin App'n	Core Stock: Flake Source	Core Stock: Wght. and % of Bd.	Core Stock: % of Resin App'n	Pressing: Temp. C°	Pressing: Time (min)	Pressing: Pressure (psi)	Pressing: Caliper	Testing: Density	Testing: Inter. Bond (psi)	Testing: Screw Holding: Face	Testing: Screw Holding: Edge	Remarks
49	LWH Mix 1 ..	800 gms 55.5%	9.0	MHW Mix 1 ..	640 gms 44.5%	9.0	157	7	480	0.76	0.72	56			
50		800 gms 55.5%	6.0		640 gms 44.5%	6.0	159	7	460	0.77	0.68	52			
51		800 gms 55.5%	8.0		640 gms 44.5%	8.0	157	7	460	0.76	0.69	46			
56		840 gms 58%	6.0	MHW Mix 3 ..	600 gms 42%	6.0	158	7	480	0.75	0.68	48			
57		840 gms 58%	9.0		600 gms 42%	6.0	158	7	480	0.73	0.63	33			Panel 57 suspect due to low density
58		840 gms 58%	7.5		600 gms 42%	5.0	158	7	480	0.75	0.68	39			
59		840 gms 58%	5.0		600 gms 42%	5.0	160	7	480	0.76	0.66	34			
60		720 gms 50%	9.0		720 gms 50%	6.0	159	7	480	0.75	0.70	52			
61		720 gms 50%	7.5		720 gms 50%	5.0	158	7	480	0.75	0.68	43			
62	LWH Mix 1 ..	720 gms 50%	6.0	MHW Mix 3 ..	720 gms 50%	6.0	158	7	480	0.76	0.69	50			
67		840 gms 58%	6.0		600 gms 42%	6.0	159	7	480	0.75	0.69	32			
68		840 gms 58%	9.0		600 gms 42%	6.0	158	7	480	0.75	0.70	60			
69		720 gms 50%	6.0		720 gms 50%	6.0	157	7	460	0.75	0.68	58	311		
70		720 gms 50%	9.0		720 gms 50%	6.0	157	7	480	0.74	0.68	53			
71		600 gms 42%	6.0		840 gms 58%	6.0	157	7	480	0.75	0.69	56			
72		600 gms 42%	9.0		840 gms 48%	6.0	157	5	480	0.75	0.70	63			
73		840 gms 58%	9.0	MHW Mix 1 ..	600 gms 42%	6.0	158	7	480	0.74	0.70	68			
74		840 gms 58%	6.0		600 gms 42%	6.0	157	7	480	0.76	0.69	46			
75		600 gms 42%	9.0		840 gms 58%	6.0	157	5	480	0.75	0.71	42			

Table 13.3e—Triple Layer Panels From Species of Flaker Particles—(*cont.*)

Panel No.	Face Stock: Flake Source	Face Stock: Wght. and % of Bd.	Face Stock: % of Resin App'n	Core Stock: Flake Source	Core Stock: Wght. and % of Bd.	Core Stock: % of Resin App'n	Pressing: Temp. C°	Pressing: Time (min)	Pressing: Pressure (psi)	Pressing: Caliper	Testing: Density	Testing: Inter. Bond (psi)	Testing: Screw Holding Face	Testing: Screw Holding Edge	Remarks
76	LHW Mix 1 ..	600 gms 42%	6.0	MHW Mix 1 ..	840 gms 58%	6.0	156	7	480	0.76	0.69	44			
77		555 gms 42%	9.0		765 gms 58%	6.0	158	7	490	0.75	0.655	40	188		
78		555 gms 42%	6.0		765 gms 58%	6.0	157	7	500	0.73	0.66	49	251		
79		765 gms 58%	9.0		555 gms 42%	6.0	156	7	490	0.74	0.63	35	190		
80		765 gms 58%	6.0		555 gms 42%	6.0	156	7	490	0.73	0.65	54	225		
81		655 gms 42%	9.0		905 gms 58%	6.0	157	7	470	0.76	0.74	53	352		
82		655 gms 42%	6.0		905 gms 58%	6.0	157	7	465	0.77	0.75	61	398		
83		905 gms 58%	9.0		655 gms 42%	6.0	156	7	465	0.77	0.75	44	389		
84		905 gms 58%	6.0		655 gms 42%	6.0	152	7	460	0.78	0.72	63	329		

Table 13.3f—Properties of Commercial Particleboards Tested at Kepong

	Caliper	Density	INTERNAL SCREWHOLDING Bond	Face	Edge	M.O.R.	M.O.E.
Danish Light Board	0.64	0.69	61	224			
Danish SWL Bonded	0.60	0.82	56+	260			
Danish SWL Bonded	0.60	0.82	58±				
K-3 (Canadian)	0.62	0.67	49	191			

14.0 APPENDIX I

14.0 COMPONENT PARTS—STUDY RESEARCH[1]

The study of commercial, semi-commercial and non-commercial Malaysian wood species for their suitability for component part manufacture was a specific assignment to aid in determining the potential utilization capability of various species within the Pahang Tenggara area.

The objective of the study, was to evaluate more predominant species of the Pahang Tenggara area and others if available, in terms of woodworking, machining and finishing properties, having in mind production facilities for an export orientated industry.

The Forest Research Institute at Kepong had conducted studies on the processing properties of 103 native species, however, the industry normally uses but a bare fraction of these. The reports of Desch and later of Lee and Lopez are basic contributions to the fund of knowledge of woods from the Malaysian forests. They provide suitable information for the local manufacturer producing for Malaysian markets.

14.1 EXPORT CONSIDERATIONS

Potential exporters, however, must give primary consideration to their marketing areas, and to the fact that major consumer countries are located in more temperate climates, with lower relative humidities, where equilibrium moisture conditions are such that wood and wood products will reach 6-11 percent moisture content rather than 18-25 percent obtained upon air-drying in Malaysia. The effect of this moisture content differential is critical to an export orientated wood industry for two reasons:

A. Because of wood shrinkage below its fibre saturation level around 25% moisture content, and

B. Because of machining differences when lumber of diminished moisture content is processed.

As wood dries below its fibre saturation level it shrinks in essentially linear relationship with the loss of moisture, but the extent of shrinkage varies not only from species to species, but also within a species. Shrinkage is also affected by the cutting pattern. Radial shrinkage is only approximately half that of tangential for any given wood, while axial shrinkage is normally only a fraction of radial and may be neglected for most furniture applications.

[1] Study Report No. 6 "Component Parts".

In addition to the above, there are the differences of machining response at differing moisture levels. It might be easier to plane and bore most woods at higher moisture levels while the water imparts some degree of plasticization, but response to these processing treatments may vary considerably, as wood is further dried. Some species will tend to become brash and give fibre pull-out, while others may toughen so that their fibres resist machine cutting and these leave fibrous rough surfaces.

Kiln drying of lumber is normally practised to overcome shrinkage problems, for by reducing the moisture content to or below the equilibrium level at which the wood is expected to be used, subsequent dimensional changes are minimized.

14.1.1 Furniture Legs—Testing

Tapered furniture legs are a high demand component part which involve a variety of operations including turning, planing, boring, sanding and wood finishing. They are also inexpensive and relatively easy to make. Thus the preparation of legs appeared to provide a very satisfactory experimental part on which to judge the suitability of Malaysian hardwoods for processing. They have one additional requirement, the legs must exhibit good screw-holding strength. Forty eight Malaysian woods have been evaluated on this basis. Several species have also been used to make other sample products of a woodworking factory.

Air dry tapered legs in 6 inch lengths of 2″×2″ lumber from each species involved have been turned on the Crabtree lathe at Forest Research Institute to diameters of $1\frac{3}{4}$″ at the larger end, tapering uniformly to $\frac{5}{8}$″–1″ at the other. Each piece was sanded, using 150 and 180 grit while on the lathe, then hand-sanded with 200 and 220 grit prior to finishing. The larger end was pre-drilled axially to a depth of $1\frac{5}{8}$″ with a high speed bit using a Black and Decker drill in order to accommodate a standard 5/16″×$3\frac{1}{2}$″ hanger bolt. Light hardwoods had a pre-drilled hole of $\frac{1}{4}$″ diameter, while both medium and heavy hardwoods were pre-drilled with a 9/32″ bit. The samples were finished with shellac. Several of the lighter coloured species were stained prior to shellacking.

A variety of other samples have been produced and finished to different extents. Small tables, cabinet door frames and Queen Anne legs are among these, and each provides some indication of the workability and versatility of these lumber species, particularly their ability to hold a corner or an edge.

Six species, kiln-dried to approximately 8 percent moisture content were edge-glued with cold-set urea-formaldehyde resin to form "plates" and these were subsequently planed and trimmed after 19 days storage in an air-conditioned room.

There is no universally accepted test for judging wood smoothness. The appraisals of the machining and finishing operations in the preparation of tapered legs or other articles is based on the specialist's judgement. In establishing each species' rating he conferred with the operator or technician concerned with the different functions, so that their opinions are weighted in the evaluation.

Again, there is no standard test for screw holding. The prime requirement of mattress manufacturers, however, is that when a leg is threaded into its tee-nut the hanger-bolt neither twist nor pull out. This is a practical test, in which the tee-nut is embedded into a short (6-8 inch) board in order to obtain adequate torque during tightening. This simulates the situation of applying the legs to mattresses or box springs.

Acceptability in the furniture trade is largely dependent upon visual inspection of sample products. Wood colour variation could be a problem, so the ability of a wood to accept a uniform stain is an attribute of considerable value in the component parts industry.

It is concluded that all Malaysian species listed in Table 14.1a with the exception of Keruing and Mempening are suitable for manufacturing furniture legs, mouldings and other furniture items of a component part plant for export provided the wood is kiln-dried, then maintained in a humidity controlled environment to minimize subsequent dimensional change.

14.1.2 Need for On-going Research

It is recommended that the Forest Research Institute or suitable private companies conduct a comprehensive and detailed study of moisture pick-up and swelling rates on a wide variety of kiln-dried species potentially suitable for an export industry. Information of this nature is of considerable practical value to the industrialist who is considering entering the export component trade. The data must provide sufficiently reliable information to indicate the degree of humidity control required for proposed operations.

All future studies of lumber and component part products undertaken at the Forest Research Institute for export consideration to more temperate climates should be conducted using wood kiln-dried to 8 percent moiture content, and that subsequent processing and testing be performed without delay to maintain as uniform moisture conditions as possible. When smaller pieces are involved, they should be prepared and stored in a humidity controlled room.

Table 14.1a—Malaysian Species Performance, in the Preparation of Air-Dried Turned Tapered Legs, for Furniture and Mattress Frames

Classification	*Species*	*Turning*	*Sanding*	*Finishing*	*Screw Holding 9/32" Hole*
HEAVY HARDWOOD ..	Balau	A	A	A	A
	Keranji	B-C	B-C	A	A
	Membatu	B-C	B-C	A	A
	Dungun	C	B-C	A	A
	Penaga	C	C	A	A
	Tembusu	A	A	A	A
	Minyak Berok	C	C	A	A
MEDIUM HARDWOOD ..	Kelat	A	A	A	A
	Kempas	A-B	B-C	A	A
	Rengas	A	A	A	A
	Merawan	A	A	A	A
	Medang	A	A	A	A
	Keladan	A-B	B-C	A	A
	Mata Ulat	A-B	B-C	A	A
	Teak	A	A	A	A
	Kulim	A	A	A	A
	Teruntum	A-B	B-C	A	A
	Perah	B	B	A	A
	Petaling	C	C	A	A
	Mempening	D	C	A	A
	Keruing[1]	E	E	A	A
LIGHT HARDWOOD ..	Nyatoh	A	A	A	A
	D. R. Meranti	A	A	A	A
	Yellow Meranti ..	A	A	A	A
	Mempisang	A	B-C	A	A
	Mersawa	A	B-C	A	A
	Kedondong	B	B-C	A	A
	Geronggang	B-C	A	A	A
	Mahogany	A	A	A	A
	Kungkur	B-C	B-C	A	A
	Ramin	A	A	A	A
	Dedali	B-C	B-C	A	A
	L. R. Meranti	A	A	A	A
	Malayan Kauri	A-B	B-C	A	A
	Punggai	A-B	B-C	A	A
	Machang	A	A	A	A
	Durian	A-B	B-C	A	A
	Sepetir	A	A	A	A
	Penarahan	A	A	A	A
	Bintangor	B-C	B-C	A	A
	Mengkulang	A-B	B-C	A	A
	Melunak	A-B	B-C	A	A
	Pelong	B-C	A	A	A
	Jalawai	B-C	B-C	A	A
	Berangan	A-B	B-C	A	A
	Terentang	B-C	B-C	A	A
	Sesendok	B	B	A	A
	White Meranti	C	C	A	A

[1] Keruing has been tried a number of times but leaves too brash a surface.

A — Excellent
B — Good
C — Fair
D — Poor
E — Unsatisfactory

Table 14.1b—Percentage Moisture Contents of Kiln Dried Woods Exposed as Indicated

Date	*Exposure*	*Accumulated Period*	*Durian*	*Balau*	*W. Meranti*	*Keruing*	*Penarahan*	*Mengkulang*
April 30	ex Kiln Dryer	—	8.4	6.9	7.8	7.9	6.4	7.6
May 19	Air-con. Room	19 days	9.1	9.7	11.5	10.6	10.9	10.6
June 15	Carpenter Shop	46 days	14.6	14.8	14.5	14.8	15.8	14.8
July 23	Air-con. Room	84 days	13.8	13.0	14.6	13.9	14.1	13.8
Sept. 6	Air-con. Room	129 days	10.3	10.0	11.0	11.2	11.3	11.2

Table 14.1c—Percentage Moisture Contents of Air Dried Woods Exposed as Indicated

July 23	Outside storage shed	6 months	19.8	15.1	18.8	18.3	20.9	18.0
Sept. 6	Air-con. Room	+45 days	12.3	13.5	13.0	13.0	13.0	13.5
Sept. 6	Outside storage shed	+45 days	14.0	16.0	19.8	17.5	21.0	19.1

15.0 APPENDIX J

15.0 INTRODUCTION

This Marketing Report has not, for obvious reasons, restricted it's scope to markets for products developed exclusively within the study area. Rather, it is an attempt to point out past trends in major world markets and to relate these trends to various known indicators and thus to obtain reasonable (conservative) forecasts of future requirements for Malaysia as a whole.

Japan, United States of America, and Western Europe (including the United Kingdom) have been the major markets for wood producing countries and are considered to continue to be so, in the foreseeable future. These markets have therefore, been studied in some depth with reference to selected lesser markets whose participation is dependent on a number of factors, the major of these being political stability and internal economic development.

The study, of necessity, is very broad and much information has been derived from studies and analysis conducted under the auspices of the United Nations, the Forestry Agency of Japan, the Malaysian Timber Export Agency, the University College of North Wales and the U.S. Department of Commerce.

Assistance has also been given by the personnel of F.A.O., State and federal officials and the members of the private sector and it's affiliated organizations, by means of statistical information and open discussions.

15.1 BACKGROUND

A very comprehensive study conducted by the F.A.O. (World Trends and Prospects, 1966) concluded that the three major market areas[1] of the non-communist world were in a deficit wood position in 1961 this deficit would increase some 73% by 1975. (Table 15.1, "Estimated Growth in Selected Major Wood Deficit Areas"). A later review (Conference on Tropical Hardwoods—Syracuse University, 1969) confirms that developments have progressed in those foreseen directions although, not necessarily, at the forecast rates.

15.1.1 Japan

The extremely rapid development of Japan resulted in a deficit of 1,255 million cu. ft. by 1967 which is some 20% in excess of the projected 1975 deficit. The revised 1975 deficit is forecast to be 1,890 millions for an increase of 840 millions or 415% over the actual 1961 deficit. As discussed in more detail later, it is unlikely that shipments of logs (which satisfied a fair portion of the deficit) from the U.S.A. will increase to keep pace with demand but, in fact, it is generally conceded that this flow will diminish annually.

[1] Major Market Areas—Japan, Western Europe and U.K., U.S.A.

15.1.2 Western Europe and U.K.

In Western Europe and the United Kingdom, imports of coniferous materials have increased more rapidly than anticipated to the detriment of Asian suppliers. However, this increase in movement is not considered to be the end-result of any technical superiority of coniferous species but rather due to an intensified marketing campaign backed by technical research, knowledgeable industry representatives, and adherence to specifications and delivery dates.

In recent view of the European situation, F.A.O. estimates that the total wood deficit of Western Europe and U.K. will be, in 1975, 4,725 million cubic feet (roundwood equivalent) rising to 5,485 million in 1980. This estimate compared with the earlier one, outlined in Table 15.1, is approximately 7% more conservative. It would appear then, that there is little doubt about the growing deficit position although the actual magnitude may vary with the forecast. It can be seen that these forecasts are only concerned with wood and do not differentiate between softwoods and hardwoods whose roles in most instances are inter-changeable. However, this afore-mentioned review by F.A.O. does point out that the European demand for sawn hardwood sleepers, plywood and veneer is expected to grow by 150 million cubic feet of log equivalent from 1965 to 1975. Volumes in addition to this (to the detriment of coniferous suppliers) will be mainly dependent on marketing effort backed by technical research.

There has been a fairly steady increase in internal hardwood log removals during the past 15 years which, based on individual reports from those countries within Western Europe, will slow down appreciably to approximately 25% of this past expansion. Because of the general concensus that round log movement will be curtailed throughout the world, imports of hardwood sawn timber, plywood and veneer could expand by 105 million cubic feet by 1975 with a further increase of 35 million by 1980.

15.1.3 U.S.A.

A paper recently prepared by the United States Forest Service states that indications are for a total increased demand for hardwood lumber, through the 1970's up to 525 million cu. ft. (log equivalent). The increased requirement for plywood and veneer, during this ten year period could rise by 280 million cubic feet (log equivalent). The major portion of this increased lumber demand and some of the plywood and veneer requirement will be satisfied internally, but beyond 1980 the U.S. must turn to the tropical forests to an ever-increasing degree.

15.1.4 Other Areas

Population increases and expanding economic development in other areas of the world will certainly result in an increased demand for wood and wood products. However, it is not felt that the demand impact of these other market areas will be as noticeable as that of the three major markets just discussed.

Eastern Europe, the U.S.S.R. and Mainland China are potentially large markets but their exploitation will be completely dependent on the political climate and resultant trade policies.

It is felt that there will be a continued increase, in demand for wood, from Australia and the Middle East. Both of these areas are long-time, customers of the Malaysian Forest Industry and there would appear to be no reason why they would not continue to be so.

15.2 WORLD PROSPECTS

The outlook for the forest industry of Malaysia can, probably be best summed by quoting a few excerpts from: The F.A.O. Secretariate Note "The Forestry and Forest Industries Sector in the F.A.O. Indicative World Plan for Agricultural Development: Asia—"Pacific Region" presented at the A.P.F.C.[1] in Korea, May 1969.

[1] Asia Pacific Forestry Conference.

Table 15.1—Estimated Growth in Selected Major Wood Deficit Areas[1]—1961-1975
Source: Wood: World Trends and Prospects, F.A.O., 1966
(Volumes—Million Cubic Feet)

Area	*Deficit*		*Present Sources of External Supply (Area and Product)*
	1961	*1975*	
E.E.C. & U.K.:			
Logs (Veneer and Saw)	1,417	1,977	N. Europe, U.S.S.R. and Canada (Sawn softwood)
			W. Africa (Hardwood logs)
Pulpwood and Roundwood ..	1,435	3,097	N. Europe and N. America (Chemical pulp, Kraft and Newsprint)
Total ..	2,852	5,074	
UNITED STATES:			
Logs (Veneer and Saw)	595	980	Canada (Sawn softwood)
			East and S.E. Asia (Hardwood—sawn, plywood and veneer)
Pulpwood and Roundwood ..	717	735	Canada (Newsprint, chemical pulp and pulpwood)
Total ..	1,312	1,715	
JAPAN:			
Logs (Veneer and Saw)	367	700	U.S.A. and U.S.S.R. (Coniferous sawlogs)
			S.E. Asia (Hardwood logs, sawnwood, plywood and veneer)
Pulpwood and Roundwood ..	—	350	Canada (Sawn timber and plywood—Coniferous)
	367	1,050	
Grand Totals ..	4,531	7,839	

[1] Deficits are expressed in roundwood equivalent.

15.2.1 **Consumption**

The indicative World Plan Study based on detailed studies of nine countries of the Asia-Pacific Region (including Malaysia) indicates that between the base years 1965 and 1985, sawn timber consumption of the region will increase nominally (381.35 to 519.06 cu. ft. per 1,000): increase for wood based panels will be ninefold (0.3 million tons to 2.7 million tons) three quarters of which will be in the form of veneer and plywood and the remainder spread almost equally over fiberboard and particleboard. For paper products, more than a sixfold (1.25 million tons to 7.9 million tons) increase is indicated.

15.2.2 **Trade Prospects**

The following quotations have been used to describe trade prospects:

> "In the more economically developed countries (North America and Western Europe), the rising demand for sawnwood, veneer and plywood manufactured from hardwoods *cannot be met adequately from internal sources* . . . . . The relatively high labour costs in the North American market certainly provide increasing access for more highly processed forms of forest products . . . . . , changing economic conditions in Western Europe favour processed over raw materials imports. The rapidly expanding economy of Japan will however, provide the greatest total market for exports of forest products from developing countries of the region. At present it is largely a market for raw materials. Eventually processed forest products exports will be going into Japan too, but it is emphasized that the quality of the products, the service behind them and the prices must be highly competitive for any country to benefit from this changing pattern of trade."

Table 15.2 "Trade Possibilities for Major Forest Products" was prepared by the I.W.P. who caution that the forecast was based on a number of assumptions—commercial, production and investment policies.

> "The build-up in exports of processed woods . . . . . mainly as broad leaved sawnwood, veneers and plywood is expected to take place largely to countries outside the region[1] as studied. Exports of sawnwood could rise from around 27.6 million cu. ft. in 1965 to 61.9 in 1975 and to nearly 82 million cu. ft. in 1985; veneers and plywood from 11.8 to 58.5 to 78.4 (the main markets are likely to be North America and Western Europe with Japan joining in the early 80's)."

15.3 PRESENT MARKET PATTERN FOR MALAYSIA TIMBER

South East Asia's major competition, in sawn lumber, is from West and Central Africa where producers have traditionally held a large share of the European and U.K. hardwood markets. However, much of the readily accessible timber in Africa has been logged and increased transport costs have reduced the number of African species which can economically compete with Malaysian timber in export markets. The unsettled political climate in some of the major production areas such as Ghana and Nigeria has had a significant effect on their industry.

Indonesia will, undoubtedly, become a significant volume producer of hardwood lumber and, while large scale competition from this source is not expected until the late 1970's, it must be considered an important upcoming competitor. It is, therefore, timely to note that Malaysia's growing importance as a wood producer can only be maintained and improved if emphasis is placed on quality control, grading standards and continuity of delivery.

The entry of the United Kingdom into the European Common Market (appears inevitable) is not expected to affect the tariff structure on imported hardwood. At the time of writing, it has been indicated that hardwood timber from both Africa and Malaysia will be dutiable at the same rate into E.C.M. countries.

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1 Region studied includes nine countries of the Asia Pacific Region which includes Malaysia.

Table 15.2—Trade Possibilities for Major Forest Products

(*a*) Quantity (000 cu. ft.)

Product	Total Exports			Total Imports			Net Exports (+) or Imports (−) to or from outside IWP Region		
	1962	*1975*	*1985*	*1962*	*1975*	*1985*	*1962*	*1975*	*1985*
Logs	293,638	609,592	677,493	28,601	115,075	147,525	+265,037	+494,517	+529,968
Sawnwood	27,648	61,934	81,919	2,825	4,732	6,356	+ 24,823	+ 57,202	+ 75,563
Veneer and Plywood ..	11,864	58,509	78,424	1,165	565	530	+ 10,699	+ 57,944	+ 77,894

(*b*) Value (million $ M)

Logs	558.0	1,079.8	1,208.3	62.5	237.1	306.9	+ 495.4	+ 842.7	+ 900.7
Sawnwood	171.2	317.9	415.9	15.2	27.9	36.7	+ 156.3	+ 281.1	+ 379.2
Veneer and Plywood ..	118.4	556.6	750.8	10.6	4.9	4.6	+ 107.8	+ 550.7	+ 746.2
TOTAL ..	847.6	1,954.3	2,375.0	88.3	269.9	339.2	+ 759.5	+1,674.5	+2,026.1

Despite competition from South America; Malaysian hardwoods have achieved increased acceptance in the U.S. market. Although volumes have fluctuated over the last two years (78,000 tons in 1969 and 44,000 in 1970), indications are that the U.S.A. will become an increasingly important customer for Malaysian timber.

Mainland China, with its 800 million citizens, probably offers the best long term market place for South East Asian producers. Initially, it is believed that the denser, more durable, species will find a ready market for construction material and railway sleepers. While China does have considerable forest area, it is a general belief that it will be some time before a strong industry is developed. Malaysia has already opened a wide breach in China's so-called "bamboo trade curtain" and is in an enviable position to exploit this market.

15.4 SOME FACTORS INFLUENCING WOOD POTENTIAL

Demand for wood and wood products, by type, is influenced by world economy (population and income) and, in fact, the structure of world economy reflects this demand in broad categories. In other words, the additional demand resulting from population growth is most likely to be for simpler forms of wood to satisfy basic requirements while that demand stemming from increased income is most likely to be in the more sophisticated wood products.

In 1951[1] the recorded world production and use amounted to approximately 810 million cubic meters of industrial wood and approximately 870 million cubic meters of fuel wood. By 1961, these two quantities had grown to approximately 1,020 and 880 million cubic meters. It can be seen, that virtually all the increase was in the form of manufacture—an increase of about 25% in a ten year period. During this period, the World's use of wood in the round (pit props, poles, posts, etc. . . .) did not grow but consumption of sawnwood increased approximately 30%. The world use of paper products grew by about 75%, fibreboard doubled, a one and one half times increase in plywood and the emergence of a new product—particleboard.

Table 15.3a—Present Market Pattern For Malaysian Timber (1970)

	Tons	%
Japan	126,000	15
Africa	155,150	18
Middle East	96,000	12
Australia	92,350	11
U.K.	77,700	9
Holland	86,200	10
France	80,000	10
Belgium	57,650	7
West Germany ...	32,000	3
U.S.A.	44,350	5

[1] *Sources:* World Trends and Prospects, F.A.O.

Table 15.3b—Malaysian/Singapore Share of Total U.K. Hardwood Imports Sawn Lumber—(000 cu. ft.)

	1967	*1968*	*1969*	*1970*
Malaysia	5,086	5,869	4,837	6,612
Singapore	1,422	2,218	2,016	1,716
	6,508	8,087	6,853	8,328
Ramin	2,549	2,712	2,211	3,057
Keruing	2,298	3,017	2,788	3,134
Others	1,661	2,358	1,854	2,137
	6,508	8,087	6,853	8,328
Total U.K. Hardwood Imports	28,359	32,472	27,253	28,310
Malaysian/Singapore Share	23%	25%	25%	29%

Source: The Malaysian Timber Export Industry.

The pattern of use varies widely throughout the world. In Africa and Latin America, 90% of wood used is in its raw form (mainly fuelwood) while North America (for example) utilizes some 20% in this manner. Add to this the fact that the tempo of demand changes rapidly with increased development (income level). As income rises, the demand for wood as fuel decreases while the requirement for wood, as a manufactured item increases rapidly.

15.4.1 Consumer Requirements

Obviously, there is no formula available which can determine the requirements of an individual consumer. However National and personal income are the general guidelines to measure a living standard as these provide the means to purchase food, clothing, housing and furnishing, luxuries and the enjoyment of leisure time.

The forest industries of the world have a great stake in the rate of development or the resultant improvement of living standards because their markets are tied very closely to three of the above-mentioned indices which reflect development:

(*a*) housing and furnishing.
(*b*) luxuries.
(*c*) enjoyment of leisure time.

15.4.1.1 Housing and furnishing

Housing provides the largest single outlet for the products of the forest and the records of those countries which publish annual housing starts and completions indicate a direct relationship between said "starts" and consumption of forest products.

Furniture consumption, to a lesser degree can also be related to housing but is probably more closely allied with income value.

In addition to new housing, home modernization or remodelling is a veracious consumer of forest products with particular emphasis on boards, panels and mouldings. Attendant to a remodelling programme is the normal desire for new furniture and, in North America and Europe, completely new marketing/advertising concepts have evolved to exploit this very lucrative field.

15.4.1.2 Luxuries

Luxuries are generally classed as items which make living more pleasant but are not necessary to good living. Certainly, there is a trend in the more developed nations to consider as essential what were formerly classed as luxuries. Most notable among luxuries are automobiles, television and stereo sets, "other than essential" furniture, cameras, etc.

Forest products play a great part in the luxury item markets, particularly in the already mentioned television and furniture fields. In addition to this, wood plays a large part in the delivery of luxury items. Packaging (crates and pallets) is an ever increasing user of wood and wood panels. Containerization, a shipping system designed to reduce freight costs has another very real (as yet uncalculated) benefit for the world wood products producers and that is the tremendous volumes of wood destined to be incorporated into the shipping containers.

15.4.1.3 Leisure time

Synonymous with a nation's development is increased income and shorter and fewer working days. The resultant leisure time has opened new avenues for market oriented businesses and this includes the forest industry. The most promising fields are in motel/hotel construction, second homes, trailers (caravans) ski-lodges, and boats.

While there has always been a reasonable amount of homecraft; the volume of wood now supplying this market, while unquantified, is substantial. The home craftsman buys in very small quantities and pays high prices for, what are mainly, high grade, Luaun/Meranti species. With the work-week becoming steadily shorter and disposable personal income increasing, one can certainly conclude that this market will become more and more important.

15.5 A SUMMARY OF WORLD TRENDS AND FORECASTS

Table 15.5a "Summary of Trade Prospects in Tropical Hardwoods" is a recapitulation of studies by S. L. Pringle, Chief Forest Economist of F.A.O.[1] which is presented in detail in Table 15.5b "Trade and Trade Prospects in Tropical Hardwoods".

15.5.1 **Imports**

15.5.1.1 Consumer importers

Those who import for internal use are included in this category and it can be seen that log imports are expected to decline slightly through 1985. Sawnwood and Plywood show substantial gains of 2.3 times and 5.5 times respectively during this same period.

[1] Conference on Tropical Hardwoods, Syracuse University, Syracuse, New York.

15.5.1.2 Consumer/processor exporter

This category includes those who import wood in log or semi-processed form for manufacture or remanufacture into export items. Log imports are expected to increase some 2.5 times annually by 1985 with a tenfold increase in sawnwood albeit from a very small starting point. The forecast indicates no activity in plywood.

15.5.2 **Exports**

15.5.2.1 Consumer/processor exporters

Naturally there would be minimal trade in logs (re-export) and a surprising decrease in sawnwood which indicates a supposition that this form of manufacture and/or remanufacture for re-export will phase out. Plywood, while showing an anticipated increase from this source, is forecast to have a growth rate much below anticipated world demand and thus, export from primary manufacturers.

15.5.2.2 Primary tropical exporters

Tables 15.5a and b forecast by implication:

(*a*) a doubling of log exports.

(*b*) two and one half times increase in sawnwood movement, and

(*c*) a six and one half times gain in plywood export.

With respect to both sawnwood and plywood; the major annual increases are expected to be between the years 1967 to 1975 and with solid annual gains through 1985.

Table 15.5a—Summary of Trade and Trade Prospects in Tropical Hardwood
(All figures in millions of cu. ft.)

	IMPORTS			*EXPORTS*			
	Consumer Importers	*Consumer Processor Exporters*	*Total Imports*	*Total Exports*	*Consumer Processor Exporters*	*Primary Tropical Exporters*	*Index of Trade Volume (Exports 1965—100)*
LOGS							
1965	218	420	638	674	4	670	100
67	210	640	850	804	4	800	120
75	218	850	1,068	950	—	950	141
85	203	1,070	1,270	1,285	—	1,285	193
SAWNWOOD:							
1965	71	7	85	119	24	90	100
67	88	10	98	119	24	90	100
75	112	21	133	192	17	175	162
85	161	74	254	252	21	230	212
VENEER AND PLYWOOD:							
1965	63	—	63	60	32	28	100
67	70	3	74	70	38	31	118
75	210	—	210	154	50	105	259
85	348	—	348	228	45	182	382
LOG EQUIVALENT:							
1965	525	430	960	1,060	133	930	100
67	560	670	1,230	1,220	150	1,060	115
75	970	890	1,850	1,720	154	1,560	162
85	1,390	1,210	2,600	2,360	154	2,210	221

Table 15.5b—Trade and Trade Prospects in Tropical Hardwoods

	Logs (millions of cu. ft.)				*Sawnwood (millions of cu. ft.)*				*Veneer and Plywood (millions of cu. ft.)*				*Total Log Equivalent (millions of cu. ft.)*			
IMPORTS OF:	*1965*	*'67*	*'75*	*'85*	*1965*	*'67*	*'75*	*"85*	*1965*	*'67*	*'75*	*'85*	*1965*	*'67*	*'75*	*'85*
(*a*) Consumer Areas	218	210	218	203	71	88	112	161	63	70	210	348	525	560	970	1,390
N. America	7	7	4	4	14	17	28	53	53	60	165	280	167	192	470	810
Europe	189	178	175	140	38	38	50	67	7	7	35	50	284	272	360	395
Others	7	7	17	35	17	14	24	53	—	—	7	14	42	35	85	140
Wood deficit areas																
Latin America	7	10	14	18	—	4	—	—	—	—	—	—	7	17	14	17
Africa	4	4	4	4	7	4	10	7	—	3	3	3	17	17	31	24
Asia Pacific	4	4	4	4	—	10	—	—	3	—	—	—	10	24	3	3
(*b*) Consumer/Processor																
Exports Areas	420	640	850	1,070	7	10	21	74	—	3	—	—	430	670	890	1,210
Japan	326	480	590	735	—	4	10	49	—	—	—	—	326	490	620	835
Other East Asia	42	84	140	175	—	—	—	—	—	—	—	—	42	85	140	175
Near East	4	4	10	17	—	—	—	7	—	—	—	—	4	3	10	31
Tropical Asia	53	70	105	140	7	7	11	17	—	—	—	—	66	85	126	175
TOTAL IMPORTS	638	850	1,068	1,270	85	98	133	254	63	74	210	348	960	1,230	1,850	2,600
EXPORTS OF:																
(*a*) Consumer/Processor																
Exporter Areas	4	4	—	—	24	24	17	21	32	38	50	45	133	150	154	154
Japan	—	—	—	—	10	10	—	—	14	10	14	—	56	60	35	—
Other East Asia	—	—	—	—	—	—	3	7	14	21	28	35	35	53	77	100
Near East	—	—	—	—	—	—	—	—	4	3	3	3	7	7	7	7
Tropical Asia	4	4	—	—	14	14	14	14	—	2	3	7	31	35	35	45
(*b*) Primary Tropical Producers	670	800	950	1,285	90	90	175	230	28	31	105	182	930	1,060	1,560	2,210
L. America	17	14	10	10	10	10	60	67	1	1	10	31	42	39	158	224
Africa	182	185	184	165	24	24	35	53	3	3	24	45	238	242	312	385
Asia Pacific	470	600	750	1,120	55	55	80	112	24	28	70	105	640	790	1,090	1,610
TOTAL EXPORTS	674	804	950	1,285	119	119	192	252	60	70	154	228	1,060	1,220	1,720	2,360

Sources: Conference on Tropical Hardwoods—Syracuse University.

World Supply and Demand of Hardwoods—F.A.O., S.L. Pringle, Chief Forest Economist.

• Totals are not additive because of rounding off.

15.6 AN ASSESSMENT OF PROSPECTS FOR TROPICAL HARDWOODS

Tables 15.5a and b; "Trades and Trade Prospects in Tropical Hardwoods" is not labelled a "forecast" but by implication, considered to be such. The Authors appear to have relied heavily on past trends which, while most necessary, can often lead to incorrect projections and doubtful conclusions.

There is overwhelming evidence supporting the fact of increasing world demand for wood and the same evidence justifies the conclusion that tropical woods will, of necessity, play an increasingly dominant role in filling these world requirements. However there is very strong doubt that the trade in tropical hardwoods will be as outlined in the Tables. Exports of logs are indicated to increase to the point that the annual trade by 1985 will be double that of 1965. This has certainly been the trend and ignoring realities, one would be justified in projecting this to continue into the future. These realities have been discussed in some detail in the main body of the report and can be summaried:

(*a*) increasing costs of shipping.

(*b*) ever increasing labour costs in developed countries.

(*c*) high costs of property and local taxes.

(*d*) a growing awareness in developing countries of the advantages (employment, foreign exchange etc. . . . .) of internal processing.

Table 15.6—A Revised Summary of Tropical Hardwood Exports
(millions cu. ft.)

Year	Logs	Sawnwood	Plywood
1977 ...	1,000	175	105
1978 ...	900	225	155
1979 ...	900	225	205
1980 ...	800	275	305
1985 ...	700	325	355

15.6.1 Conclusions

It is considered, then, that for these above noted reasons, log movements (exports) will become increasingly more limited. An option is that log exports will probably reach a peak in the late 1970's of approximately 1,000 million cubic feet and the trend beyond this point will be down, at an ever-increasing rate.

15.7 UNITED STATES OF AMERICA

Imports of hardwood logs and hardwood products into the United States, in 1969 were of the following magnitude:

Logs	... 30 Million Board Feet
Lumber	... 450 Million Board Feet
Plywood	... 4.25 Billion Square Feet
Veneer	... 1.85 Billion Square Feet

This volume represents approximately 384 million cubic feet of round wood and some 75% or 289 million originated from Asian countries.

The present total consumption of hardwood lumber has averaged 7.3 billion board feet in recent years and is projected to reach 10.5 billion in 1980—an increase of 40%.[1] The demand for hardwood plywood and veneer is projected to rise from 4 billion square feet in 1969 to 7.5 billion in 1980—an 88% increase.[1]

Implicit in these assumptions is that sufficient hardwood timber will be available either from domestic or foreign sources to maintain relative price stability.

Table 15.7; "U.S.A. Hardwood Imports" illustrates, in graphic form, the trends in imports for a twelve year period commencing 1957. Logs have been reduced 45%—sawn timber has increased 84%—plywood some 425% and veneer 240%.

15.7.1 Residential Construction in the United States

One of the better barometers employed in predicting consumption patterns and trends in the use of hardwood plywood, lumber, mouldings and furniture components is the probable number of housing starts. Long term forecasts indicate considerable growth in the volume of residential construction.[2] By the mid 1970's, new

1 Mr Dwight Hair—Assistant Director—Marketing Research Service U.S.D.A. Washington.

2 "The Demand and Price Situation for Forest Products, 1967".
U.S. Department of Agriculture, Forest Service, Misc. Pub. 1066.

family formations will increase by 1.3 million per year over 1940 and by 400,000 per year over the average annual rate of family formations in the period from 1960-65. Replacement of existing dwelling units is also likely to expand in a society which is becoming increasingly opulent. The renewal programmes, which are in prospect in large metropolitan areas, will augment further the demand for hardwood. It has been predicted that new housing starts will reach 2 million units by 1975. This represents a 66 percent increase over the 1.2 million units started in 1966. The forecast increase in housing starts and the associated increase in demand for furniture and similar household items indicate a major expansion in markets for hardwood products.

The extent to which Malaysia will participate in this potential market will depend, for the most part, on these factors.

(*a*) Cost of forest-based products relative to cost of similar products from a competing country.

(*b*) Cost of forest-based products relative to competing materials.

(*c*) Availability of supply and continuity of delivery.

(*d*) Quality of products relative to competition.

(*e*) The extent of marketing programmes and information services by both Government agencies and private industry.

Table 15.7—U.S.A. Hardwood Imports 1957-1969 (approximate)

Year	Logs (Million Board Feet)	Lumber	Plywood (Billion Square Feet)	Veneer
1957	94	245	0.8	0.5
1958	69	225	1.0	0.5
1959	69	330	1.5	1.0
1960	81	275	1.2	0.9
1961	50	245	1.3	0.9
1962	63	325	1.5	1.3
1963	53	325	1.8	1.4
1964	63	335	2.0	1.8
1965	56	350	2.3	1.9
1966	53	425	2.8	1.8
1967	44	340	2.6	1.7
1968	45	362	3.9	2.3
1969	38	465	4.3	1.8

15.7.2 Construction

Projected growth in construction, in the furniture industry and in related areas suggests substantial increase in the future use of hardwood products. In view of the continuing decline in the size and quality of hardwood trees in the United States, it is reasonable, to assume that market demands will be met by increased imports.

In all probability, the factory-built housing industry will be accelerated to meet the demands of the predicted housing starts. At a recent meeting of the Forest Products Research Society in Washington, D.C., it was predicted that the off-site, manufacturing of buildings or building components will radically change both the mass market for housing and traditional practices in the industry. By the mid-seventies, one third of all single family houses will be completely manufactured in modules at factories and the modules will be assembled at the home sites. Most apartments of lower income families will be built and completely furnished at nearby factories. Substantial numbers of motels and hotels will be similarly constructed. Hardwood products lend themselves admirably to these new methods of construction.

15.7.3 Trends in Wood Utilization

As has been mentioned, there is a definite trend towards more complete finishing in the country of origin. It is reasonably safe to predict that this trend will continue mainly due to wage costs in developed nations and continually rising freight rates.

1970-1975 Imports in developed countries consisted of the following categories:

(*a*) Sawn/air-dried timber,

(*b*) Finished (planed) dry-kilned, timber.

(*c*) Moulding and specialities (sash, planking, flooring, etc. . . .)

(*d*) Partially, finished component parts.

(*e*) Raw plywood and blockboard (sanded only).

The above items, as such, will tend to decrease between 1976-1990 and be replaced with:

(*a*) More completely dried and finished products—overlays and pre-finishing in plywood—staining and finishing of furniture parts.

(*b*) Knocked-down cabinets and furniture (degree of assembly will depend on ratio of freight to, and wage rates within, the importing country).

(*c*) Particleboard—mainly in the form of cabinet and furniture components—core for high-grade plywood (sliced veneer overlaid).

(*d*) Housing Modules.

15.7.4 **Furniture**

There are clear indications from many sources[1] that furniture, radio, stereo, television cabinets and various other case goods manufacturers in the North Eastern and mid-West regions of the U.S.A. are switching more and more to production systems based on the purchase of cut-to-size plywood and panel boards. These items are ordered as face panels, sides, drawers, backs, etc. for quick incorporation into finished products. The high cost of labour, land and plant facilities have stimulated this development.

The rapid growth in containerization, whereby items are "stuffed" into large containers at the producing factory and delivered by truck, rail and water to the buyer, will do much to keep transportation costs within economic bounds and assist developing nations to compete on world markets.

[1] Reports of Canadian Trade Commissioners, Chicago, New York, Cleveland—"Foreign Trade"—1968, Published by Department of Industry, Trade and Commerce, Ottawa.

15.7.4.1 Example

The cost of materials purchased by North-Eastern U.S.A. furniture manufacturers (excluding Ohio) was $835 million in 1966. If it is assumed that the plywood content of the total industry corresponds with Canadian experience, then 4.3% of total requirements indicates a North-Eastern regional market for hardwood plywood in the order of U.S. $36 million annually. This represents about 200,000,000 square feet of plywood (1/4 inch basis) and is approximately identical to Malaysia's 1968 total production of 211,000,000 sq. ft. (5 mm. basis).

Quality, service, regularity of delivery and competive prices obviously are critical elements in penetrating export markets. Korean and Taiwanese recent dominance (at the expense of Japan) of the U.S. panel market clearly corroborates these factors.

15.7.5 **Market for Panelling Plywood**

This market accounts for 66% of the total hardwood plywood consumed in the U.S.A. Annual consumption of pre-finished $\frac{1}{4}$ inch wall panelling currently is estimated at 2.5 billion square feet. An area which could be very worthwhile exploring for Malaysia's export markets is the rapidly expanding mobile home and travel trailer industry. Pre-finished, vinyl-overlaid and printed panels are important for the interior finishing of these housing units. Newly married, retired and semi-transient people find that mobile homes provide economic solutions to their shelter needs.

As of September, 1968, mobile home shipments were reported to be 31% greater than 1967 while single family housing starts were only 7% greater for the same period. Currently about 80% of all United States housing selling under $20,000 per unit is manufactured off-site. A similar trend, although not as marked, can be found in other developed countries where high "assembly-line" techniques are adopted to offset high labour and operating costs. It seems obvious that Malaysia could share in this growing market with the development of it's forest industry coupled with an energetic marketing programme.

15.8 JAPAN

Consumption of wood (in all forms) has climbed from 1,960 million cu.ft. (roundwood equivalent) in 1960 to 3,150 million in 1969. Wood has long been an important material in Japan's economic and cultural life. The post-war recovery and rapidly expanding economy have been reflected

by the ever-increasing, consumption of wood products. (Table 15.8a "Timber Consumption in Japan").

Japan relied heavily on roundwood imports to supplement her own heavily depleted forests (overcutting through the war years) during the 1950's but processed wood imports have increased rapidly during the last decade. Rising wages, a labour shortage, ever-increasing log prices and log handling problems in over crowded ponds have all contributed to increased imports of sawnwood, veneer and plywood. Processed wood rose from 3% in 1960 to 17% in 1969, of total imports. Most authorities agree that this trend will continue. (Table 15.8b "Trends in Japan's Timber Supply").

South East Asia is the largest source of supply for logs and processed wood (42%) followed by North America and the U.S.S.R. Logs were the almost exclusive form of wood shipped to Japan from the south seas until 1966 when sawnwood, veneer and plywood started increasing.

15.8.1 Future Prospects

The importance of Japan as a market for the Malaysian forest industry cannot be underestimated. Future developments in Japan's economy and the interplay between her own forest resources and alternative sources will be the main factors in assessing market prospects for the Malaysian forest industry.

Japan's low rate of population increase and rapid economic expansion are expected to continue, resulting in a very affluent nation. It would appear however, that some areas of growth or expansion have not kept pace and the government's economic planners are attempting to rectify this imbalance.

There is a severe shortage of housing and much of what exists is inadequate. Social services, in general, have lagged behind industrial development. Emphasis is now being placed on improving housing so the construction sector can be expected to grow to a much faster rate than the overall economy.

A labour shortage is developing in Japan which is particularly critical in the forest industry where pay and working conditions are traditionally less attractive than in some other industries. In an effort to counter this problem, the industry is consolidating and modernising while at the same time, production costs are increasing. This trend, combined with Japan's improved balance of payments position and the trade and foreign investment liberalization, has increased the involvement of Japanese industry in foreign countries. This involvement has resulted in a swing to imports of finished and semi-finished wood products from what was, exclusively, roundwood.

Table 15.8a—Timber Consumption in Japan
(Million Cu. Ft./Roundwood Equivalent)

Year	Sawnwood	Pulpwood	Plywood	Other	Total
1960	1,320	338	112	189	1,950
1961	1,430	385	119	192	2,120
1962	1,470	414	144	178	2,200
1963	1,550	440	154	154	2.300
1964	1,630	450	173	143	2,400
1965	1,650	430	182	136	2,395
1966	1,760	480	220	136	2,600
1967	1,930	580	262	130	2,900
1968	2,150	602	312	130	3,040
1969	1,930	680	396	133	3,150

Imports to Japan by Source
(Million cu. ft.—Roundwood Equivalent)

Year	South Seas	North America	U.S.S.R.	Other	Total
1960	171	21	35	14	241
1961	195	81	45	21	342
1962	242	95	63	24	424
1963	280	136	66	28	510
1964	300	165	192	35	692
1965	325	172	198	38	733
1966	380	220	126	59	785
1967	440	365	178	82	1,065
1968	460	530	206	119	1,315
1969	630	500	228	150	1,508

Source—Forestry Agency, Japan.

Table 15.8b—Trends in Japan's Timber Supply
(Millions Cu. Ft./Roundwood Equivalent)

Year	Domestic Supplies	IMPORTS Logs	Processed Wood	Total Volume	% of Supplies	Total Supplies
1960	1,710	234	7	241	12	1,951
1961	1,770	318	28	346	16	2,116
1962	1,770	390	31	421	19	2,191
1963	1,780	470	45	515	22	2,295
1964	1,810	550	45	595	25	2,405
1965	1,760	585	49	634	26	2,394
1966	1,820	710	77	787	30	2,607
1967	1,850	920	147	1,067	37	2,917
1968	1,710	1,080	238	1,318	44	3,028
1969	1,600	1,250	252	1,502	48	3,102

Source—Forestry Agency, Japan. Tuolumne Corporation.

The Forestry Agency of Japan projects the 1975 demand for wood and wood products as follows:

Table 15.8c—Estimates of Future Requirements Million cu. ft. (roundwood equivalent) 1975 Requirements

	1969 Actual	Low Est.	High Est.
Sawnwood ...	1,930	2,540	2,640
Plywood ...	396	510	560
Pulpwood ...	680	1,090	1,200
Others ...	133	87	87
	3,139	4,227	4,487

These estimates do not include approximately 280 million cu.ft. of waste and residues from Japan's own industry and which will be utilized in pulp and particleboard.

The Tuolumne Corporation, in a recent study conducted on behalf of F.A.O. prepared a projection of the likely sources to fill Japan's requirements. They (Tuolumne) caution that the estimates are dependent on many factors but are based on the best estimates and latest information available Table 15.8d "Japan's Present Supply and Forecast Demand—(by source)" presents these estimates and after deducting the domestic supply plus the U.S.S.R. and "others" the balance will, in all probability be supplied from the south seas region. Malaysia's share of this market will, mainly, be dependent on efforts expended.

15.8.2 Potential Suppliers to Japan

Of all the major supply regions (North America, U.S.S.R. and South Pacific) North America is currently the most important, but there is a very strong expectation that this will change. There is strong pressure in the U.S.A. to restrict log exports (Canada has always limited this type of export) and total imports to Japan, from this source, declined from a high of 420 million cu.ft. in 1968 to 367 million in 1969.

Unofficial Japanese forecasts are for an increase to 387 million cu. ft. in 1970 and volumes from North America can arbitrarily assumed to remain at this level. Expended allowable cuts in western Canada and an increasingly attractive market in Japan could raise this level. On the other hand, additional restrictions on log exports coupled with an ever-increasing, internal demand (housing) could, very likely, lower it.

Supplies in 1975 from U.S.S.R. of 280 million cu. ft. are projected on the basis of recent trends in Soviet trade with Japan (Tuolumne report to F.A.O.). They take into account, recently signed agreements for Japanese participation in the exploitation of the Siberian forest resource but, in view of climatic conditions and shortage of management expertise, immediate increases are unlikely.

"Other" sources are assumed to supply double the 1969 volume by 1975, this assumption is based on past growth rates and Japan's interest in developing new sources of wood supplies. When "other" sources are deducted, a deficit of 735 million cu. ft. remains to be filled by the south seas region.

15.8.3 Japan's Participation in Foreign Operations

Indonesia is the main center of interest for Japanese companies attempting to establish a resource base. Their main activity to date, appears to be towards a guaranteed log supply but processing plants will follow if Indonesia enforces contract agreements.

The principal companies involved are the large trading houses and, recently, some of the larger sawmills and plywood firms. Surprisingly, though, Japan has not the necessary experience for foreign operations and a period will be required to develop managerial and operating skills.

There appears to be a strong movement in Japanese industry away from the traditional concepts into complete integration whereby production, distribution and use are under one control. Carried to a logical conclusion, it is a reasonable assumption that complete utilization, in all forms, will be at the supply source. Malaysia can benefit greatly from this trend but must establish and maintain good "ground-rules" which will encourage foreign investment and, at the same time, maximize the return to Malaysia.

Table 15.8d—Japan's Present Supply and Forecast Demand (By Source) 1969, 1975 and 1985
(Million m^3 Roundwood Equivalent)

	Demand by end-use				
	Sawnwood	*Plywood*	*Pulpwood*	*Other*	*Total*
ACTUAL 1969:					
Demand	55.4	11.3	19.4	3.8	89.9
Domestic Supply	27.7	0.6	14.8	3.8	46.9
Imports:					
South Seas	6.9	10.7	0.3	—	17.9
North America	10.5	—	3.8	—	14.3
U.S.S.R.	6.0	—	0.5	—	6.5
Others	4.3	—	—	—	4.3
Total	27.7	10.7	4.6	—	43.0
ESTIMATED 1975					
Demand	75.7	16.0	34.2	2.5	128.4
Domestic Supply	27.0	0.5	23.9	2.5	53.9
Imports:					
North America	11.0	—	1.9	—	12.9
U.S.S.R.	8.0	—	1.0	—	9.0
Other	8.6	—	1.9	—	10.5
Total	27.6	—	4.8	—	32.4
Potential for South Seas	21.1	15.5	5.5	—	42.1
Total	48.7	15.5	10.3	—	74.5
ESTIMATED 1985					
Demand	83.0	20.0	60.0	2.0	165.0
Domestic Supply	32.0	1.0	35.0	2.0	70.0
Imports:					
North America	11.0	—	1.9	—	12.9
U.S.S.R.	8.0	—	2.0	—	10.0
Other	8.6	—	3.4	—	12.0
Total	27.6	—	7.3	—	34.9
Potential for South Seas	23.4	19.0	17.7	—	60.1
Total	51.0	19.0	25.0	—	95.0

NOTE: Pulp import projections from the South Seas in 1975 assume the higher of a range of estimates of pulpwood deficits.
Source: Forestry Agency, Japan.
The Tuolumne Corporation.

15.8.4 End Uses

Construction	48%
Furniture	24
Packaging	13
Joinery	10
Other	5
Total ...	100%

Construction is the largest market for Malaysian sawnwood although hardwoods only represent a small portion of the total wood used. Furniture consumes approximately 50% of the volume used by construction and this is almost exclusively produced in Japan from log imports with a small amount re-manufactured from sawnwood.

15.8.4.1 Construction

Japan has suffered a chronic housing shortage since the war years despite a relatively high rate of construction. Since 1965, when an absolute shortage (dwelling units *vs.* households) was overcome, the emphasis has been on improved housing with more space per occupant and the need to accommodate the migration of people from rural to urban areas. The rise in marriage and birth rates immediately after the war is expected to result in a rapid increase in household formations for the next few years. The tradition of two and three generation households is no longer as prevalent which, in effect, will also contribute to increased households.

The current Economic and Social Development Plan is forecasting 27 million new housing units between 1966 and 1985. Of the 27 million, 11.2 million are classed as replacement and 15.8 million as additional. These projections also include an improvement in the standard with floor areas increasing from 600 to 850 sq. ft.

15.8.4.2 Furniture

The consumption of wood for furniture has grown steadily during the past decade and is expected to accelerate within the next two to three years as income continues to increase. 35 million cu. ft. of sawnwood was used in furniture during 1960. By 1968, the use had risen to 56 million. Tropical hardwoods account for 65% of all wood used in furniture and of this volume approximately 67% was of the Lauan/Meranti Group.

15.8.4.3 Packaging

Very little information is available on particular applications of wood in this field, however, it is known that lower grades of the lighter-weight species are used most commonly. Typical uses are crating for machinery, pallets, and wire-bound boxes. With a continuing rise in industrial activity, a corresponding requirement for packaging materials can be assumed.

15.8.4.4 Market development

Dipterocarps (Merantis, Keruing) and a limited number of other species are readily accepted in the Japanese markets and one should assume that many other species could be introduced, if the supply was guaranteed and the new species were promoted to their best end-use. It has been suggested that, over the long term (10-15 years), there will be a transformation in Japanese purchases from logs to finished products which could present some problems. The Japanese use a wide range of grades and specifications which are "catered" to by local industry and, while this is changing due to consolidation of the industry; it will be a long time before "Western-type" standardization is accepted. To penetrate and gain a position in the Japanese market (as any other market), manufacturers must recognize that volume, reliability of supply, price and technical suitability are the criteria.

15.8.5 Veneer and Plywood

The consumption of plywood is rising rapidly in Japan and is outstripping domestic production which must provide for establishment export markets.

Between 1962 and 1969, Japanese production increased at an average annual rate of 17%. The most substantial increases in consumption were by the construction industry. Type 1 (weather proof bond) plywood is becoming increasingly popular and consumption has increased at the rate of 47% per year. The utilization of plywood in concrete forming, siding, flooring, sub flooring and sheathing has resulted, also, in an increasing average thickness. (Table 15.8e, Plywood Production in Japan).

Development of plywood for interior finishing has progressed rapidly with secondary finishing—printing, overlayment and fancy veneer faces. An estimated 29% of 1969's production received secondary factory finishes.

Table 15.8e—Plywood Production in Japan
(Million sq. ft./4 mm. basis)

Class	*1962*	*1963*	*1964*	*1965*	*1966*	*1967*	*1968*	*1969*
VENEER CORE:								
Type I	240	280	410	540	770	1,380	2,600	3,600
Type II	1,890	2,520	3,410	3,990	5,200	6,620	8,040	9,380
Type III	2,280	2,170	2,100	1,820	1,530	1,160	870	600
	4,410	4,970	5,920	6,350	7,500	9,160	11,510	13,580
Special Core Blockboard	90	100	120	110	140	140	180	200
Other	80	110	100	110	110	150	170	220
	170	210	220	220	250	290	350	420
Totals ..	4,580	5,180	6,140	6,570	7,750	9,450	11,860	14,000

The Trend in Japan's Plywood Production (Type and Thickness)
(1,000 sq. ft.—Actual Surface)

	Type I	*Type II*	*Type III*	*Totals*
Less than 3 mm.				
1968	207,959 ..	4,123,844 ..	1,116,959 ..	5,448,761
1969	201,683 ..	4,830,978 ..	781,534 ..	5,814,195
1970	254,566 ..	6,019,926 ..	412,979 ..	6,687,471
3 mm. to 6 mm.				
1968	717,339 ..	3,885,865 ..	140,749 ..	4,743,952
1969	907,117 ..	4,187,738 ..	31,936 ..	5,126,791
1970	1,135,032 ..	4,242,817 ..	26,372 ..	5,404,220
6 mm. to 12 mm.				
1968	453,634 ..	612,563 ..	26,552 ..	1,092,718
1969	553,975 ..	791,157 ..	3,369 ..	1,348,501
1970	518,583 ..	776,260 ..	2,088 ..	1,296,932
Thicker than 12 mm.				
1968	392,054 ..	306,836 ..	20,053 ..	718,942
1969	789,209 ..	483,267 ..	19,902 ..	1,292,378
1970	1,304,122 ..	568,119 ..	194 ..	1,872,434

Source: Japan Plywood Manufactures Association.

15.9 WESTERN EUROPE

United Kingdom, West Germany, France, Italy and Netherlands.

According to a study by the University College of North Wales; these five countries accounted for 87% of total European tropical hardwood consumption. The total consumption of hardwoods in 1967 was 210 million cubic feet, mainly from Africa and the preponderance in log form. The United Kingdom is the largest importer of sawnwood, plywood and veneer of the five countries classed as Western Europe.

15.9.1 Future Potential

The U.C.N.W. study, mentioned previously, is probably the most detailed examination of hardwood consumption in this geographical area and resulted in demand projections through 1983 (Table 15.9a, Present and Projected Demand for Tropical Hardwoods) of an annual increase in sawnwood consumption of 1.5% and in plywood and veneer of 4.5%.

Total growth in hardwood sawnwood consumption has been very modest—an increase of 10% since 1960. Total sawnwood consumption includes softwoods and hardwoods and of the total it would appear that hardwoods only comprise some 21%. Western Europe is a heavy consumer of high-grade softwood from Canada and the U.S.A. but the growth in softwood consumption seems to have levelled out with hardwoods accounting for the major portion of the total increase since 1960.

When attempting to forecast, in general terms, the potential for Malaysia in Western European Markets; the prime consideration will be Malaysia's ability to compete with:

A. Supplies from Africa (Hardwood)

B. High grade Softwoods from North America

Table 15.9a—Present and Projected Demand for Tropical Hardwoods in Western Europe
(1,000 cu. ft.)

	Actual	*Projected*	
	1967	*1975*	*1983*
Sawnwood[1]			
Construction ...	23,100	25,200	28,700
Furniture	25,585	30,135	32,900
Other	10,150	12,425	14,175
Total ...	58,835	67,760	75,775
Plywood and Veneer			
Decorative face[2] ...	15,505	21,000	26,670
Non-decorative ...	13,790	19,320	26,145
Core stock	27,580	46,830	68,950
Total ...	56,875	87,150	121,765

Certainly, all producing countries must be able to meet competition but it is considered that the ability to meet this competition will be the prime determinent (as opposed to forecasting future potential and assuming that all producers will share in this potential, albeit in varying degrees).

15.9.1.1 Supplies from Africa

As previously mentioned, Western Europe with the exception of the U.K. is a prime importer of hardwood logs mainly from Africa. Obviously, then, Europe's manufacturers, aided by many years of accumulated expertise, will be extremely difficult to supplant. However, readily available logs are becoming scarce in Africa and one can assume that future supplies will be more costly. Add to this, the ever-increasing cost of labour and property within Western Europe and it can be surmised that this local industry will be hard-pressed to maintain its position.

The obvious alternative would be primary manufacturing in Africa with European capital and expertise. This is considered extremely likely and could effectively block Malaysia (and all South East Asia) from any degree of dominance in the European market. However, if present European manufacturers were to re-locate in the raw material sources, there would be a considerable time lag between the decision to do so and the actual economic production of well-manufactured

[1] Mostly joinery.
[2] Excludes West Germany—no consumption figures, apparently available.
Source: University College of North Wales.

wood products. In addition the generally unsettled political climate would inhibit the full scale investment necessary to restrict South East Asian participation in European markets.

It can be generally concluded, then, that South East Asia will, at the very least, maintain its present position in the Western European market and Malaysia's share will depend exclusively on quality, price and continuity of delivery.

15.9.1.2 High-grade softwoods from North America

Tropical hardwoods and high-grade softwoods are mainly utilized in furniture and joinery where appearance is the prime consideration. Softwoods have long been popular for these end uses and there would appear to be no thought that "fashion" will change so radically as to favour hardwood over a material as well established as the softwoods. There is, however, one consideration which could "tip the scales" in favour of tropical hardwoods and this is price. The ever-increasing costs of production in North America must inevitably reflect in prices which will make these products less attractive (in spite of fashion) to the consumer . The projections for increased demand in total sawnwood, plywood and veneer are modest but there is an indicated trend of a change from softwood to hardwood in buying habits since 1960 and this trend could well be accelerated if prices for hardwood can be maintained at a more or less, reasonable level (relative to softwood).

15.9.2 **End-Uses**

There is a surprising lack of adequate statistical information on end-uses of hardwood products. Intensive surveys have never been carried out on a country by country basis and studies which have been made are either extremely general and therefore not suitable as a basis on which to plan a marketing programme, or have been directed towards a specific market for a specific product or range of products.

End-uses, as discussed here, are mainly drawn from studies by F.A.O., G.A.T.T., the U.C.N.W. study and discussions with marketing and production representatives of a limited number of Companies. Table 15.9b "Summary of End-Uses for Tropical Hardwoods by Percentage".

15.9.2.1 Furniture

Furniture is the largest single consumer of sawn hardwoods in Western Europe with approximately 46% of total consumption. However, it is significant that the use of sawnwood, in this application, has declined somewhat relative to the increase in furniture production. Although both F.A.O., and G.A.T.T. estimate an increase of sawnwood into furniture (20-30%), the growth rates are substantially below the anticipated growth in furniture consumption.

It seems that the main reason for the absolute decline in sawnwood into furniture is due to the substitution of plywood, blockboard and particleboard. Metal and plastics have replaced wood in certain end-uses, such as chairs, office furniture, and institutional fixtures. Furniture is also the largest single end-use for plywood and blockboard but just as plywood has been seen to replace sawnwood; particleboard is becoming more popular and particularly in the less expensive furniture.

Table 15.9b—Summary of End Uses for Tropical Hardwoods by Percentage

Country	*Furniture*	*Construction*[1]	*Transport*	*Ship & Boat*	*Others*[2]
West Germany	50-55	36-40	2	2	6-9
United Kingdom	40	40	3-5	5-7.5	7.5-10
France	40	36-41.5	2-3	5-6	8-12
Netherlands	40	27	3	2-3	26-28
Italy	65	30	—	—	5
Belgium	45	35	2	4-5	10-13

[1] Includes doors and paraquet flooring.
[2] Includes 4-5% in packaging and 17% in hydraulic works.

Sources: F.A.O./E.C.E.
University College of North Wales.
The Tuolumne Corporation.

15.9.2.2 Construction

Approximately 34%sawnwood consumption is in construction with Merantis, Keruing and Ramin, the most important of the Asian species. While there has been a general decline in the amount of wood per dwelling; this has been in construction grades and does not appear to have affected high grade softwood and tropical hardwoods which are used where appearance is an important factor. The main requirements for this end-use (joinery, mouldings built-in-furniture and trim) are ease of working, dimensional stability, and good acceptance of a clear finish, all of which point to the eminent suitability of tropical hardwoods (properly manufactured). Preferences for colour vary from country to country and within a country but France and Denmark appear to be the only areas which have a definite bias towards red woods to the virtual exclusion of other colours.

As with sawnwood; the second highest consumer of plywood is in construction. Softwood is the more popular of the plywoods in heavy construction work (structual and concrete form) due mainly to the excellent marketing work of North America producers/representatives and not for technical reasons (apart from the fact that all Canadian softwood plywood is bonded with a weather and water proof adhesive) The recent trend by Asian producers towards an overall thicker panel and an increase in exterior-bonded panels indicates recognition of the opportunities for hardwood plywood in the heavy construct field.

Probably the most important end-use for tropical plywood and veneer is in those areas where appearance is the prime consideration although some hardwoods (Keruing) are superior to Douglas fir and should be promoted for those end-uses where strength, durability and abrasive-resistance are most important . Hardwood plywood should continue to dominate as a panelling material with some erosion of traditional markets by the thin pressed boards which have a simulated embossed wood-grain pattern.

15.9.2.3 Other uses

While the full range of end-uses for sawn hardwoods cannot be listed; the major markets are in railway sleepers, vehicle bodies, boat and shipbuilding, and containers. There has been some erosion of these end-uses by other materials and products but it is a general belief that, contingent on price, the absolute demand will continue to increase. G.A.T.T. has forecast that this "other use" category could double in consumption by 1975 in comparison with 1965. G.A.T.T. offer no basis for this assumption and it does appear somewhat optimistic.

In other end-uses for plywood such as trailers (caravans) boats, ships, and packaging, softwood plywood holds a strong position relative to hardwood although all plywood is facing stiff competition from metal, plastics (fibreglass) and pressed boards. Packaging offers much scope for plywood although competition is keen and prices are low but Malaysia has an advantage with relatively lower labour costs and the advantages of "Pioneer Status". This end-use could ideally serve for the introduction of lesser-known species.

15.10 PRESENT MAJOR MARKETS

Japan, Australia, the United Kingdom, Western Europe, Africa and the United States of America are presently the major market-places for sawn timber from Malaysia.

Japan, United States of America, and Western Europe, as a whole, have been dealt with in some detail. Following are brief comments on some of the other markets and short summaries on individual countries comprising what is referred to as Western Europe. (Table 15.10, Exports of Major Species by Major Destinations).

As was previously mentioned, statistical information is scarce relative to imports, exports and individual country consumption. However, it appears generally that tropical hardwood consumption is on the increase and while the major import of these materials is in log form, there is a very difinite trend towards the importation of manufactured products.

15.10.1 **United Kingdom**

In 1970, the U.K. was the fifth largest purchaser of Malaysian sawn timber (81,400 tons) and Malaysia is undoubtedly the most important Asian source of hardwood to the U.K. Growth in consumption of sawnwood is very low (0.8% per year) and imports represent some 94% of the U.K's consumption. It is however, a fact that approximately 85% of total sawnwood imports are softwood, with Canada, the largest supplier. Further to this, it appears that only 50% of total hardwood lumber imports are from the tropical countries and Malaysia (including Singapore) commands about 50% of this volume.

Consumption of plywood increased 47% between 1963-1967 although as in sawn timber, the major portion was softwood. The major end-uses for the softwood plywood are in shuttering and construction, which, until recently, has been a very minor item in Asian production. The recent trend (in Asia) towards thicker panels with "weather proof" bounding should do much towards increasing the opportunities for hardwood in this market.

15.10.2 West Germany

West Germany relies on external sources for approximately 33% of her total sawnwood requirements. During the period 1960-65, West Germany experienced a mild "boom" in house construction which has reflected in an increase in sawnwood consumption. However, since 1965 there has been a gradual decline in consumption. Indications are that this decline has now levelled out and consumption is expected to, more or less, stabilize during the foreseeable future. It is estimated that current consumption of tropical hardwood sawntimber is 8,855,000 cubic feet, of which, 5,300,000 cubic feet is derived from imported logs.

15.10.3 France

The most recent figures available (1966) indicate that France imports approximately 20% of her tropical hardwood requirements in the form of sawnwood. During the period 1960-66, consumption of hardwoods increased at an average annual rate of 3% while that of softwood was 11%. While recent figures on imports and consumption are not available, it is known that France imported 50,750,000 cubic feet of tropical hardwoods (in log form) during 1968 for both sawn timber and plywood. During this same year, some 8,575,000 cubic feet of tropical sawn timber was also imported and Malaysia/Singapore supplied about 55% of this volume.

15.10.4 Italy

Italy is very reliant on external sources for her sawnwood supplies, of which hardwoods accounted for 36% of apparent consumption in 1968. Tropical hardwood is a very small portion of total hardwood consumption in Italy as Europe and the U.S.S.R. are the main suppliers. However, Malaysia/Singapore supplies approximately 50% of the total tropical hardwoods consumed in Italy and in 1970 Malaysia's share equalled 2,100,000 cubic feet.

15.10.5 The Netherlands

Approximately 90% of the Netherland's consumption of sawnwood is imported and of this, some 25% is tropical hardwood, mainly from Malaysia/Singapore. During the period 1960-1968, growth in hardwood consumption increased some 53% (albeit from a low base) while that of softwood only increased about 17%. In 1970 Holland imported 3,800,000 cubic feet from Malaysia and was the fourth largest single customer.

Table 15.10—Export of Major Species by Major Destinations, 1970

	Japan	*Australia*	*United Kingdom*	*Holland*	*Belgium*	*Africa*	*U.S.A.*	*France*	*West Germany*	*Totals*
Damar Minyak	41	1,383	41	9	33	27	924	—	—	2,458
Jelutong	358	2,432	4,081	330	86	2,642	624	35	62	10,650
Kapur	4,207	8,870	4,717	36	—	—	4,274	—	—	22,104
Kempas	10,851	1,523	770	24	323	369	977	39	6,018	20,894
Keruing	78,265	4,615	51,202	20,703	2,090	1,362	21,400	303	15,872	195,812
Meranti D.R.	61	748	4,655	44,027	46,023	14,031	180	35,488	3,724	148,937
„ L.R.	282	63,688	7,082	85	9	10	11,193	165	25	82,539
„ Red	981	6,761	600	172	70	28,393	706	—	—	37,683
„ Yellow	682	24	1,645	81	264	123	18	139	126	3,102
Mersawa	12,764	33	16	—	—	230	7	—	11	13,061
Mengkulang	—	333	4,904	460	2,073	—	—	4,715	652	13,137
Melanti	3	2,371	—	—	—	—	—	—	—	2,374
Merbau	52	2,130	502	10,188	1,014	38	—	469	174	14,567
Nyatoh	298	11,326	230	64	87	68	—	—	—	12,073
Punah	—	—	30	—	46	—	—	—	—	76
Ramin	28	362	768	61	—	296	1,106	289	98	3,008
Sepetir	501	510	164	—	19	—	158	—	—	1,352
	109,374	108,109	81,407	76,240	52,137	47,589	41,570	41,542	26,762	584,730

Total—584,730 tons—29,236,500 cu. ft.
Representing 85% total shipment.

Source: Timber Export Statistics (In tons of 50 cu. ft).

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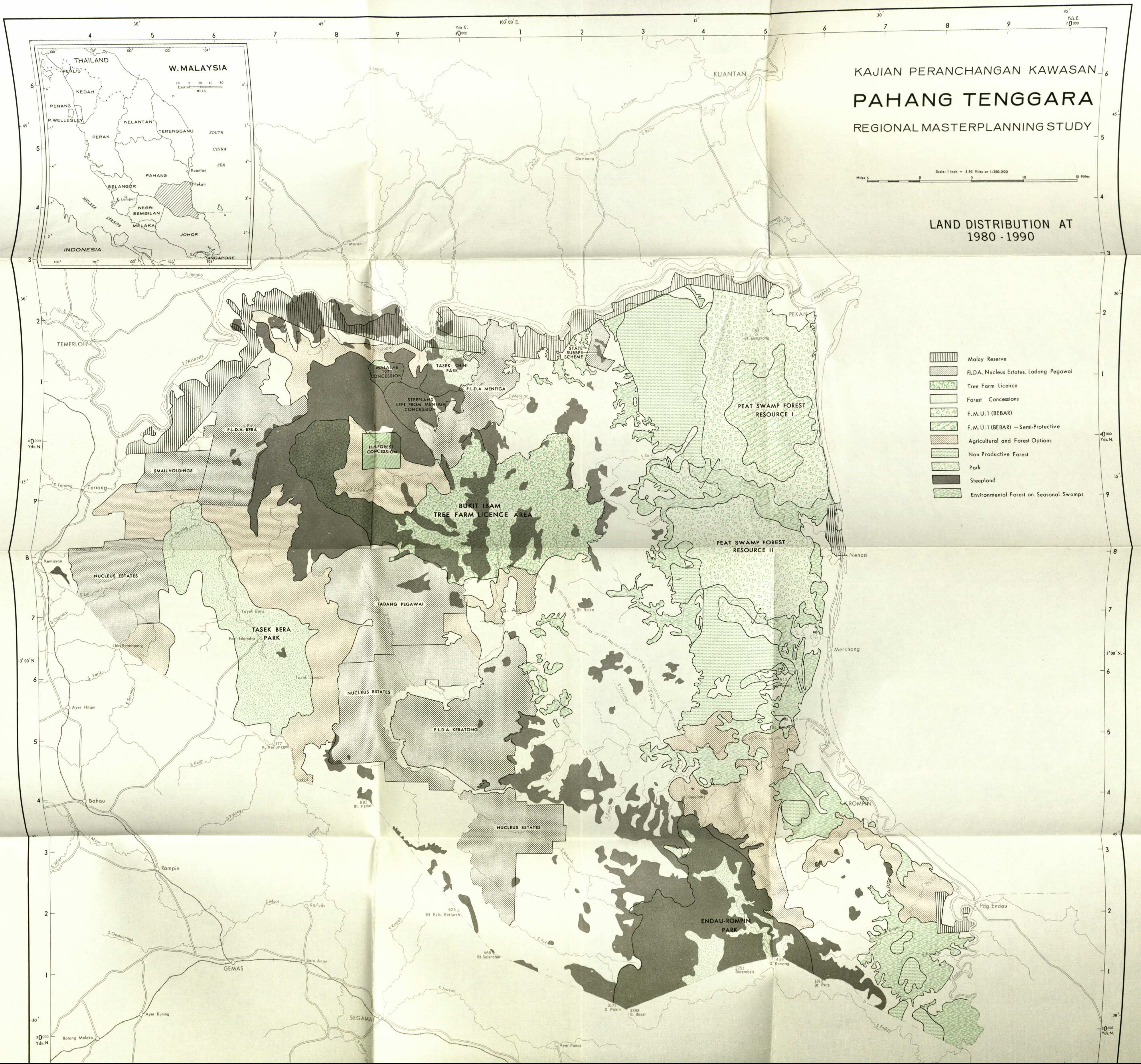

KAJIAN PERANCHANGAN KAWASAN
PAHANG TENGGARA
REGIONAL MASTERPLANNING STUDY
Scale: 1 Inch = 3.95 Miles or 1:250,000
LAND DISTRIBUTION AT 1980 - 1990
Malay Reserve
F.L.D.A. Nucleus Estates, Ladang Pegawai
Tree Farm Licence
Forest Concessions
F.M.U.1 (BEBAR)
F.M.U.1 (BEBAR) —Semi-Protective
Agricultural and Forest Options
Non Productive Forest
Park
Steepland
Environmental Forest on Seasonal Swamps
W. MALAYSIA
THAILAND
PERLIS
KEDAH
PENANG
P. WELLESLEY
KELANTAN
TERENGGANU
PERAK
SOUTH CHINA SEA
PAHANG
SELANGOR
NEGRI SEMBILAN
MELAKA
JOHOR
INDONESIA
SINGAPORE
KUANTAN
PEKAN
TEMERLOH
Gambang
Maran
Teriang
Kemayan
Bahau
Rompin
GEMAS
SEGAMAT
Ayer Hitam
Ayer Kuning
Batang Melaka
Nenasi
Merchong
K. ROMPIN
Pdg. Endau
MALAYSIA 1972 CONCESSION
TASEK CHINI PARK
STATE RUBBER SCHEME
F.L.D.A. MENTIGA
STEEPLAND LEFT FROM MENTIGA CONCESSION
F.L.D.A. BERA
SMALLHOLDINGS
H.H. FOREST CONCESSION
BUKIT IBAM TREE FARM LICENCE AREA
PEAT SWAMP FOREST RESOURCE I
PEAT SWAMP FOREST RESOURCE II
NUCLEUS ESTATES
LADANG PEGAWAI
TASEK BERA PARK
F.L.D.A. KERATONG
ENDAU-ROMPIN PARK


KAJIAN PERANCHANGAN KAWASAN
PAHANG TENGGARA
REGIONAL MASTERPLANNING STUDY
PROPOSED AREA DEVELOPMENT
1972 - 1980
W. MALAYSIA
THAILAND
PERLIS
KEDAH
PENANG
P.WELLESLEY
KELANTAN
TERENGGANU
PERAK
SOUTH
CHINA
SEA
PAHANG
Kuantan
Pekan
SELANGOR
NEGRI
SEMBILAN
MELAKA
JOHOR
INDONESIA
SINGAPORE
Malay Reserve
F.L.D.A, Nucleus Estates, Ladang Pegawai
Tree Farm Licence
Forest Concession
Logging Allocation on Non-Committed Agricultural Land
F.M.U.1 (BEBAR)
F.M.U.1 (BEBAR) —Semi-Protective Forest
Committed Logging on Agricultural Development
Park
Steepland
KUANTAN
Gambang
TEMERLOH
PEKAN
STATE RUBBER SCHEME
MALATAB 1972 CONCESSION
TASEK CHINI PARK
MENTIGA FOREST CONCESSION
MENTIGA FOREST CONCESSION
PEAT SWAMP FOREST RESOURCE I
F.L.D.A. BERA
H.H FOREST CONCESSION
SMALLHOLDINGS
CONTRACT LOGGING AREA
Teriang
BUKIT IBAM TREE FARM LICENCE AREA
PEAT SWAMP FOREST RESOURCE II
Nenasi
Kemayan
NUCLEUS ESTATES
LADANG PEGAWAI
Kg. Aur
BUKIT IBAM LOGGING AREA
TASEK BERA PARK
SPECIAL COMPLEX LOGGING AREA 1973-1980
Merchong
NUCLEUS ESTATES
F.L.D.A. KERATONG
GENERAL LANJUT AREA
SITE OF I II III
SPECIAL COMPLEXES
Bahau
K.ROMPIN
NUCLEUS ESTATE
LESONG TREE FARM LICENCE AREA
Rompin
I II III
SPECIAL PLANTS LOGGING AREA 1973-1980
Pdg. Endau
ENDAU-ROMPIN PARK
LESONG LOGGING AREA 1974-1976
GEMAS
SEGAMAT
Batang Melaka
Ayer Kuning
Jementah