REPORT ON PRELIMINARY SURVEY FOR DEVELOPMENT OF FOREST RESOURCES IN CAMBODIA

December, 1970

OVERSEAS TECHNICAL COOPERATION AGENCY

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PREFACE

At the request of the Government of Cambodia, the Government of Japan sent a survey team to Cambodia early this year for the purpose of conducting a preliminary survey on the development of forest resources there.

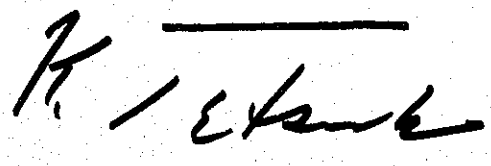
On behalf of the Japanese Government, the Overseas Technical Cooperation Agency organized the survey team of six members, headed by Mr. Keizo Hara, Senior Researcher, Government Forest Experiment Station of Ministry of Agriculture and Forestry.

The team stayed in Cambodia during the period from February 2 to February 28, 1970, and conducted surveys on various problems in relation to the development of forest resources in Cambodia and also exchanged views and ideas on the problems with the official of the Government of Cambodia.

After returning to Japan, the team reviewed the results of the survey referring to various materials and data collected through the survey work and has prepared the present report for the submission to the Government of Cambodia. It is hoped that this report will be of some help to the development of forest resources in Cambodia and will contribute to the further promotion of friendly relations between Cambodia and Japan.

On behalf of OTCA and the survey team, I wish to express my sincere gratitude and appreciation to the Government of Cambodia and other related organizations for their cordial support and cooperation extended to the team.

December, 1970



Keiichi Tatsuke
Director-General
Overseas Technical Cooperation Agency
Tokyo, Japan

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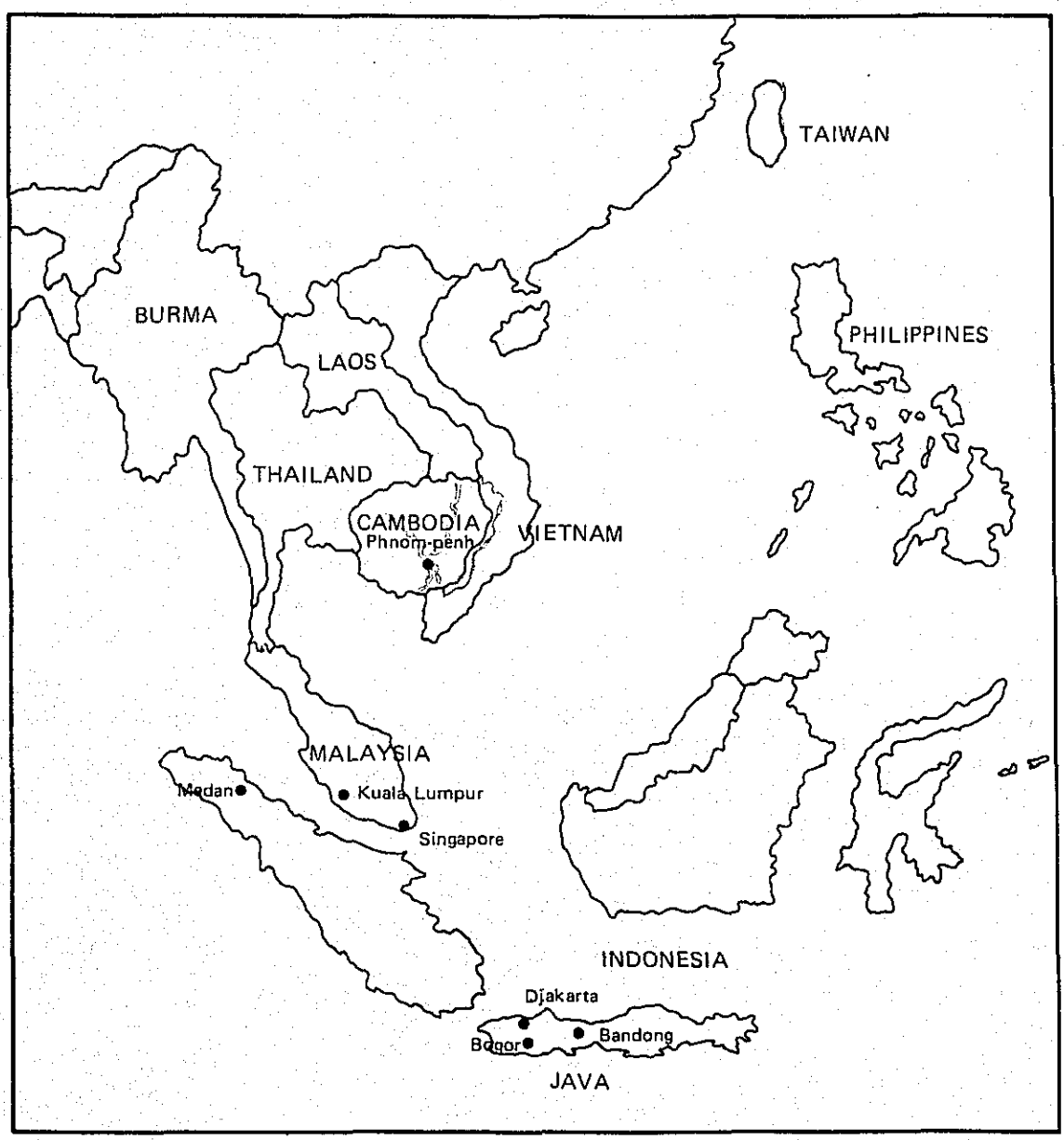
Fig. 1 Map of Southeast Asia



CHAPTER I. INTRODUCTION

1-1 Purpose of Survey

Until very recently, the coast area of Cambodia, or the area surrounded by the Cardamones and the Elephant Ranges and by the coast line of Siam Bay, which is referred to as "the coast area" in this report, was covered with untouched tropical humid forest, mainly due to inaccessibility for lack of transport facilities.

In recent years, however, development of the area centering on Port Kompong-som has been under way and additionally due to the growing demands for Cambodia's lumber in oversea countries, development of forest resources with an enormous capital investment is becoming increasingly active.

Though the development of forest resources in Cambodia for the purpose of exporting lumber to Japan was initiated by Japanese private capitals some 10 years ago, further development of forest resources of a large scale is expected to be seen in the near future with the mutual cooperation between the two countries.

Incidentally, the trade between the two countries is extremely unbalanced and this fact has become a major obstacle to the economic growth in both countries. For this reason, development of forest resources in the coast area for the purpose of exporting lumber to Japan is considered very significant. In view of the present situation surrounding the forests in the coast area, cutting is expected to make a good headway in these forests in the days to come. Against this prospects, the Government of Cambodia has a serious concern over the preservation of forest resources and the question of the disposition of cut-over areas, particularly the question of regeneration in these areas.

The mission of the team was to provide technical assistance in the solution of these problems.

1-2 Members of the Survey Team

Head of team	:	(Overall responsibility, general forest industry) Keizo Hara, Senior researcher, Government Forest Experiment Station, Ministry of Agriculture and Forestry
Member	:	(Forest Management and Economics, land use) Isamu Nomura, Doctor of Agriculture, The Chief of Forest Economics Section, Government Forest Experiment Station, Ministry of Agriculture and Forestry
Member	:	(Forest nursing) Kinji Hachiya, The Chief of Silviculture Second Section, Government Forest Experiment Station, Ministry of Agriculture and Forestry

Member	:	(Forest survey) Mitsuru Gamanuma, Forest officer, Planning Section, Forestry Agency, Ministry of Agriculture and Forestry
Member	:	(Technical cooperation) Isao Takahashi, Overseas Technical Cooperation Officer International Cooperation Section, Agricultural Economic Bureau, Ministry of Agriculture and Forestry
Member	:	(Coordination) Tokio Kano, Overseas Technical Cooperation Agency

1-3 Itinerary of Survey Team

February 2	:	Arrival in Phnom-penh
February 3 - 4	:	Consultations with staff of the Japanese Embassy and officials of the Forest Agency of the Cambodian Government Courtesy calls to the Foreign Ministry and other authorities concerned
February 5 - 6	:	Survey of Kirirom pine forest
February 7 - 9	:	Visit to the Forestry Experiment Station, surveys of semi-humid forest and dry forest near the Lake Tonle Sap, summarization of collected data and material, rest period
February 10 - 11	:	Survey of SKEF cutting area near Kompong-som
February 12	:	Trip from Kompong-som to Chruoy-smach
February 13 - 16	:	Survey of SOKECIA cutting area
February 17	:	Same as above, some members made a trip from Chruoy-smach to Phnom-penh and were engaged in the collection of data and materials at the Forestry Agency, Ministry of Agriculture and the Geography Bureau.
February 18	:	Same as above
February 19	:	Trip from Chruoy-smach to Kompong-som
February 20	:	Trip from Kompong-som to Phnom-penh
February 21 - 23	:	Aerial surveys of regenerated area in the coast district, summarization of data and material, preparation of an interim report
February 24	:	Presentation of an interim report to the Japanese Embassy
February 25	:	Presentation of an interim report to the Director of the Forestry Agency, Cambodian Government

February 26	:	Preparations for departure
February 27	:	Departure from Phnom-penh Arrival in Tokyo

1-4 Acknowledgements

We wishes to acknowledge its appreciation of the impressive cooperation and assistance extended by all authorities and people concerned with this survey.

Especially kind cooperation and support were extended to the survey team by Mr. Soun Kaset, Director of the Forest Agency, Mr. Tiang Song Hang, Inspector for the Coast Area and other officials of the Forest Agency, Mr. Shigeru Aoki, President of the Cambodian Development Company Ltd., Mr. Tsutomu Tadakuma, Vice President of SOKECIA, Mr. Shohei Hashimoto, Director General of SOKECIA, Mr. Shigeru Kikuchi, Director of Chruoy-smach Operation Office. Smooth progress of the survey was possible only through the cooperation of these people, to whom we offer our heartfelt thanks. We all members of the team, express our heartfelt gratitude to Mr. Suon Kaset, Director of the Forest Agency, who was kind enough to hold a farewell party for the team members prior to their departure from Cambodia.

CHAPTER II. DEVELOPMENT OF FOREST INDUSTRY IN THE COAST AREA

2-1 Concept of Regional (Economic) Development and Its Course

One shall not greatly err when he says from a common sense point of view that "the development or the economic development of a certain region" means an attempt to raise the level of real per capital income in that particular area.

It is in the developing regions or countries that this issue creates a real problem. Now, we shall see through what steps the economic development takes place in the developing regions or countries. For the theories of development in the developing regions or countries, there are several theories such as those developed by G. Myrdal, R. Nurkse and Marx (1) and one of them deals with the industrial structural approach (2). With this approach an attempt is made to elucidate the income gap between regions by analysing the difference in the industrial structure. However, unless a thorough study is made as to the cause of differences in the industrial structure between regions, there is some danger that the discussion will be lead to a mere formalism and to a simple idea that the rapid industrialization must be pursued at any cost for the economic development of the developing regions or countries. For this reason, it is very important to give serious attention to this question.

As the basic type of economic growth (3), the generally conceivable form is that with the progress of tree cropping industry and agriculture the profit produced by agriculture is first accumulated, which in turn become the capital to support the future growth and prepares a material base for agricultural production of higher productivity and manufacturing industry of low productivity, upon which an entrepreneur with a vision for the basic trend of economy makes his appearance and through such process of advancing to the stage of higher dimension, the level of industrial development is also raised gradually. The entrepreneur referred to this discussion is neither the individual nor a group of individuals but may be the government and may well be the government in the case of SE countries. What is of prime importance is that the process of transition from the stage of agriculture or tree cropping industry to manufacturing industry or the process of transition from one stage to another in the manufacturing industry must be implemented in such a form that there will be no overstrain in the economic society.

The second importance is that the procurement of capital which is an essential part of the material means to make such transition possible must be made within the framework of the economy in that country as a rule.

It is important, therefore, to plan industrialization according to the degree of progress of the economy while paying attention to the balanced growth consistent with the progress of economy in the country.

The need for stressing the importance of agricultural development despite the fact that the manufacturing industry is originally regarded to have higher production capacity and productivity is due to the fact that firstly, the developing countries which are wishful for a hasty

economic growth often tend to take a radical course straying from the course of balanced development and secondly, these developing countries with low productivity of agriculture despite a large number is employed population still have many things to accomplish in agricultural sector in order to raise income level of the people. This is particularly true with the countries whose supply of food has to depend on import.

In the smooth process of transition of economy from low level to high level both in agriculture and manufacturing industry it is natural that a certain amount of surplus is accumulated and the accumulation is then invested as a capital for the economic growth in the next stage.

For the accumulation of capital, however, mere dependency on the natural transition of the economy will not produce sufficient amount of capital to secure expected growth of economy. For this purpose, there must be efforts of various degrees on the part of the governments of developing countries. To attain this goal, constant efforts must be made on the part of the government or leaders in the economic world in each developing country to take such measure as the adoption of appropriate tax, saving, banking and insurance systems.

Discussed so far is the basic pattern of the economic development but there is another aspect that must be added to the concept of the economic development. It may be natural in the developing region or countries that the growth of primary industry such as tree cropping industry and agriculture is given priority as a correct order or in other words it may be said that the growth of manufacturing industry is realized on the basis of primary industry. However, this is only one aspect of the true fact. This is due to the fact that the development of primary industry is further promoted by the deployment of industrialization as the next step.

The above discussion dealt with the general pattern of economic growth of development. Now, in the following section we shall attempt to put in this picture the forest industry which is the main theme of this report.

The relation of forest industry to the general economy of a country is similar to that already mentioned in the discussion for agriculture. That is to say, in the developing regions or countries the elements with low productivity are first developed and become the source of raw material, manpower and capital, thus accomplishing industrialization gradually and the evolution of industrialization has repercussions over the growth of forestry, as stated previously. The question here is the relation between agriculture and forest industry.

Generally speaking, it is evident that agriculture (rice, maize, other tree-crops including oil palm, coco palm and rubber) surpasses forest industry in terms of productivity. Furthermore, the amount of required capital for agriculture is far less than that required for the manufacturing industry, or it may be said that in agriculture, production is possible with a minimum amount of capital investment and less manpower. Also in agriculture it is possible to secure food production which guarantees the minimum standard of living.

Under normal conditions, therefore, evolution of agriculture is usually given priority. This is not only because of the above-mentioned capital and productivity but also because

in correlation with the two factors that stimulate the production of forest industry.

(1) In the course of the economic growth, the development of agriculture and the settlement of farmers are prerequisite to the generation and growth of demands for lumber. It is needless to say that the generation and growth of demands for lumber stimulate the utilization of forest resources which have so far been left unattended and held produce value. Thus the enterprise of forestry comes into being even with the burden of capital investment and evolves for further development (in other words, the forest becomes the object of capital investment and part of capital circulation).

(2) With the development of agriculture and the settlement of farmers, the manpower necessary for the management of forest industry can be secured at the same time.

As stated above, the full-fledged evolution of forest industry is generally dependent on the development of agriculture from the standpoint of economic growth in the developing regions or countries. In other words, unless there is a development of agriculture, there can be no full-fledged progress of forest industry. (Not the mere despoilment but including the regeneration).

The above is the basic concept of economic development in developing regions or countries as a general consideration.

The next discussion will deal with a study on the development of the coast area which is the least developed region in the country and the main subject of the discussion in this report.

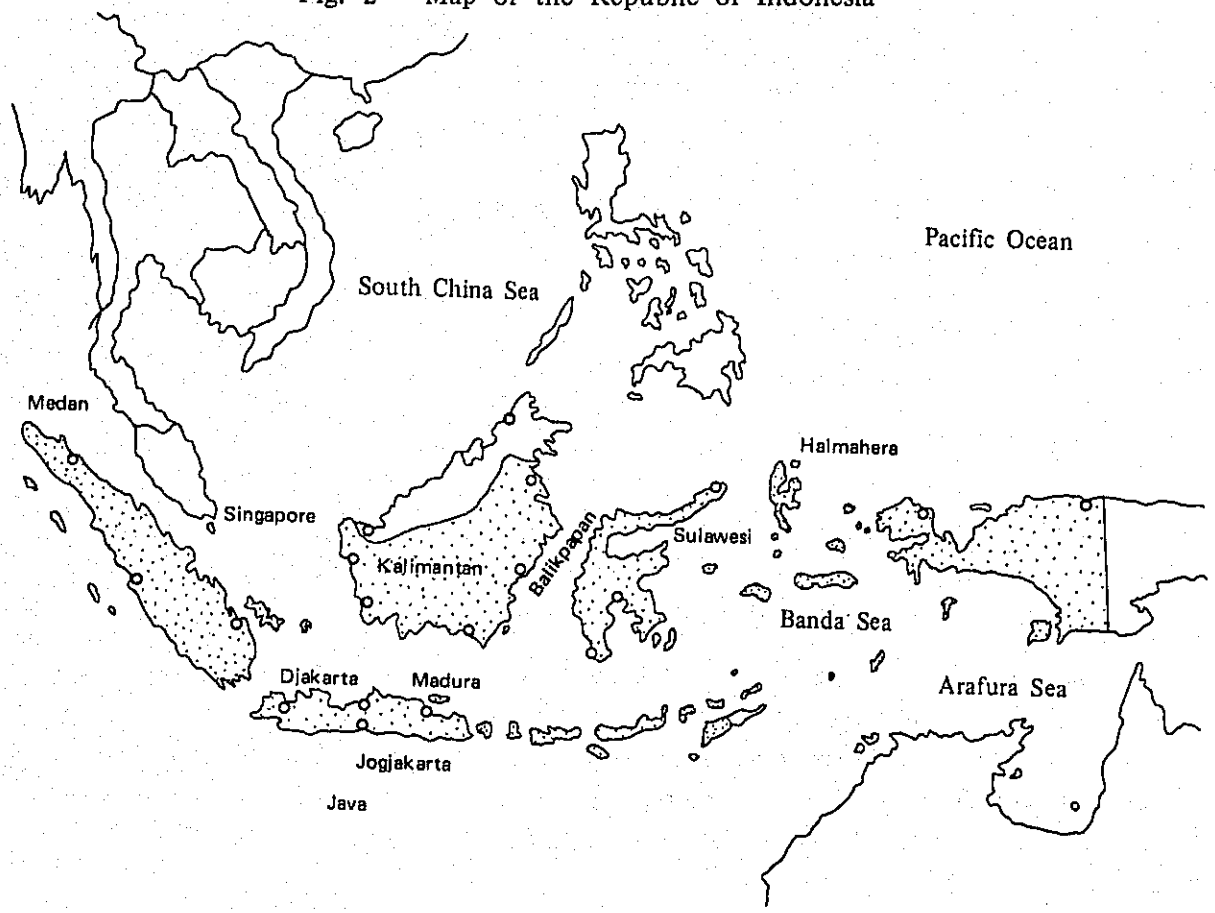
Before proceeding, however, it is considered beneficial to introduce the present state of economic development and land use in the Republic of Indonesia and Malaysia, both of which have considerable achievements in the forest industry from a historical point of view and where the team had an opportunity to make necessary surveys, in a sense of adding concrete examples of the abstract observation.

2-2 Economic Development and Land Use in the Republic of Indonesia

The Republic of Indonesia comprises 13,677 islands scattered in the ocean extending from Long. 95°E to Long. 163°E and from Lat. 7°N to Lat. 12°S (See Fig. 2).

The total land area is approximately 190,400,000 ha. (about 5 times that of Japan). Among the main islands are Java and Madura with an area of 13,200,000 ha, Sumatra with an area of 47,400,000 ha, Kalimantan with an area of 54,900,000 ha, Sulawesi (formerly Serebes) with an area of 19,000,000 ha, and West Irian (formerly West New Guinea) with an area of 4,130,000 ha.

Fig. 2 Map of the Republic of Indonesia



Historically, the interior colonies such as Java, Madura, Bali have made achievements in the development but the exterior colonies are relatively slow in the development.

Thus, there is a difference in the economic structure even within the Republic of Indonesia, but generally speaking, the economic structure of the Republic can not be said to be at a high level.

This is plain from the study on the structure of domestic production of the Republic (1967), comprising agriculture accounting for 47%, mining industry accounting for 3%, manufacturing and commerce accounting for 5% and others accounting for 17%. It may be said, therefore, though the Republic of Indonesia, along with Thailand, the Philippines and Malaysia, has achieved industrialization of relatively high level within the country compared with other countries of Southeast Asia, it may be said that the economy of the country is still in the stage that has to give priority to agriculture in the course of economic development.

What is the present state of land use centering on agriculture which still holds an important position in the whole economy of the Republic?

The land under cultivation totals approximately 12,730,000 ha. of which rice paddy accounts for 57.2%, followed by maize accounting for 20.7% and cassava which accounts for 10.9%.

Table 1 Area Under Cultivation

Description	Area	Percentage
Crops	1,000ha	%
Rice	7,289	57.2
Maize	2,630	20.7
Cassava	1,394	10.9
Sweet potato	392	3.1
Peanuts	377	3.0
Soy beans	651	5.1
Total	12,733	100.0

Next with the land for tree-crop farming, the land owned by the Estate totals 780,000 ha. of which rubber plantation accounts for 63.9%, oil palm plantation for 13.3% and tea garden for 9.1%, as shown in Table 2.

The above figures represent only the land owned by Estate (Estate agriculture) and therefore, do not include the land owned by resident farmers. Although the accurate figure for the total area of land used for tree-cropping farm can not be obtained if the land owned by resident farmers is added to this figure, the total area is estimated at about the double the figure of the Estate. However, it is very unlikely that there is a wide difference in the percentage.

Table 2 Land Under Cultivation for Tree-Crops (Estate only)

Description / Type of crops	Area (1,000 ha)	Percentage (%)
Rubber	498.8	63.9
Tea	70.7	9.1
Coffee	46.2	5.9
Oil Palm	104.2	13.3
Cinchona	5.3	0.7
Sugar	55.5	7.1
Total	780.7	100.0

Agricultural production such as rice which is produced mainly by small scale resident farmers is striking contrast to the tree-cropping industry such as rubber plantation, the majority of which is managed by large scale estate agriculture.

Finally, let us turn our eye to the forest industry. The forest area in Indonesia totals 1,217,746 km^2, accounting for 2/3 of the total land area of the country.

The forest area of the country is administratively divided into two categories, namely the reserved forest which is considered as the object of enterprise and the non-reserved forest which is not given such consideration.

The forest area under each category by region is shown in Table 3.

Table 3 Forest Area in Indonesia

Description / Region	Forest Area (km^2)		
	Reserved Forest	Non-Reserved Forest	Total
Java & Madura	29,908	–	29,908
Sumatra	77,932	206,260	284,192
Kalimantan	39,084	375,616	414,700
Sulawesi	16,892	82,208	99,100
Molucca & West Irian	–	375,000	375,000
Nusa, Tengara	12,182	2,656	14,838
Total	175,998	1,041,740	1,217,738

A study on the ownership of forest area in the country revealed an overwhelming share of national forest, as shown in Table 4 below.

Table 4 Ownership of Forest

Type of ownership / Region	National Forest (1,000 ha)	Joint-owned Forest (1,000 ha)	Total (1,000 ha)
Java & Modura	3,000	–	3,000
Sumatra	20,600	7,800	28,400
Kalimantan	41,500	–	41,500
Sulawesi	9,900	–	9,900
Molucca & West Irian	37,500	–	37,500
Nusa, Mongal	1,500	–	1,500
Total	114,000	7,800	121,800

In recent years, however, an attempt is being made in Java to increase the area of farmer owned forest to 22 to 30% of the total forest area in Java. For this reason, the privately owned forest is expected to increase considerably in the future.

Now, on the present state of the development of forest resources in this country, it is no exaggeration to say that the most advanced form of forest development is artificial silviculture.

As shown in Table 5 below, the total area of artificial silviculture in the country as of 1968 is 1,190,000 ha.

Table 5 Area of Artificial Silviculture in Indonesia

(1,000 ha)

Tree age	Pine	Other coniferous trees	Total of coniferous trees	Eucaly-ptus	Teak	Other broad-leaved trees	Total broad-leaved trees	Total of coniferous and broad-leaved trees
0 ~ 5	31	5	36	1	80	79	160	196
6 ~ 10	18	3	21		61	37	98	119
11 ~ 20	42	5	47		121	77	198	245
21 ~ 30	26	9	35		93	284	377	412
31 ~					221		221	221
Total	117	22	139	1	576	477	1,054	1,193

Silviculture in Indonesia began in Java where economic development was most advanced and with teak which is considered as one of the most precious woods in the world.

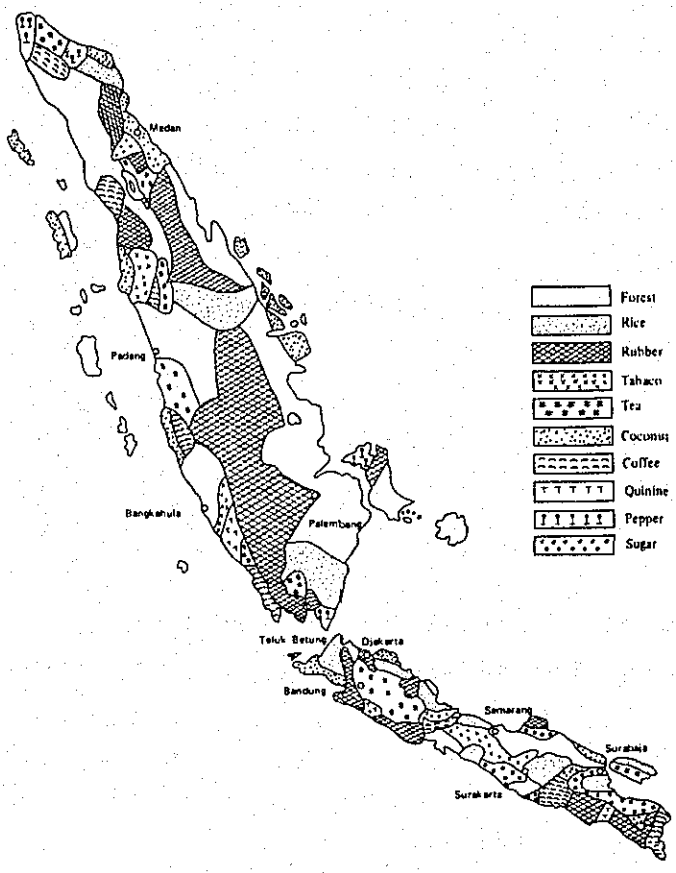
The teak wood, in view of its value, may be considered as a tree-crop rather than timber. For this reason, the plantation of teak is seen in the hilly land less than 500 m above sea-level in the Central and East Java. The full-fledged silviculture in these regions dates back to the latter half of the 19th century when the country was a colony under the Dutch control.

In addition to the teak plantations which concentrates in the Central and East Java, there are also plantations of Pinus merkusii covering an area of about 55,000 ha, mahogany (Swietemia macrophylla) plantations covering an area of 24,684 ha, rose wood (Dalliergia latifolia) plantations in an area of 17,532 ha, plantations of Agathis loranthiforia in an area of 12,465 ha, bamboo forest with an area of 10,462 ha, Kayu Putih (Melaleuca leucadendron) oil palm plantation with an area of 4,292 ha and others in an area of 189,267 a, in a total of 297,243 ha.

In Sumatra, which follows Java in the degree of development, there is a plantation of Pinus merkusii covering an area of about 18,000 ha. (Beside Java and Sumatra, plantations of Pinus merkusii are also seen in Bali where the forest covers an area of 4,600 ha and in Sulawesi where the forest covers an area of 3,129 ha.

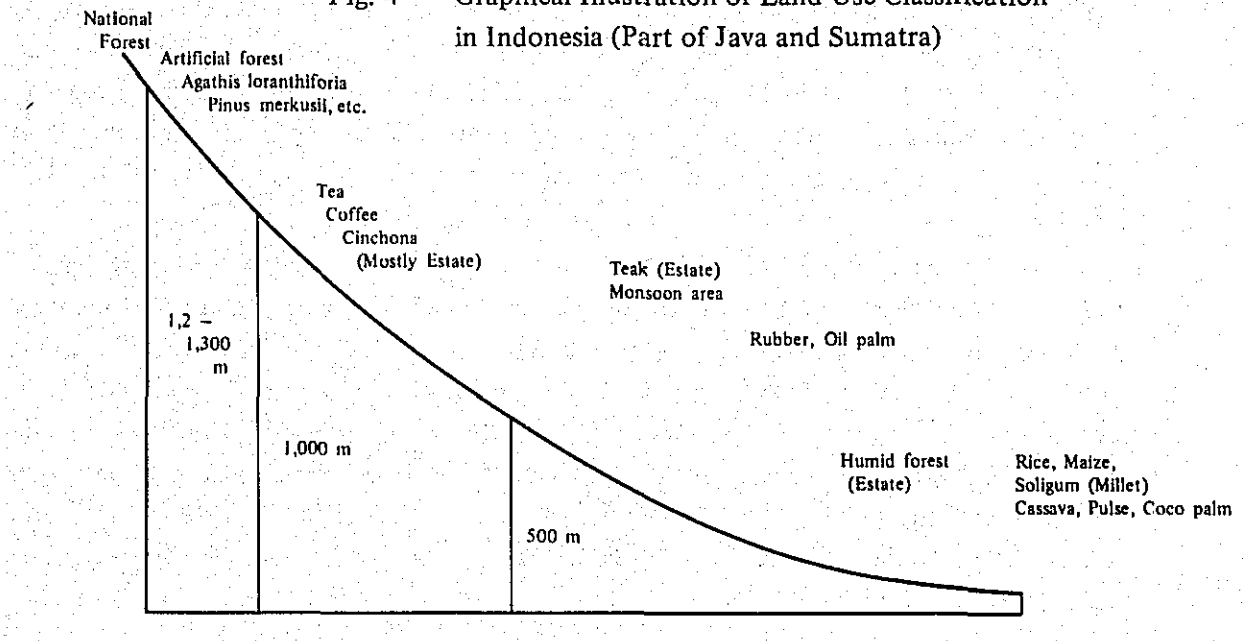
In the above discussion we have dealt with the present state of land use in the Republic of Indonesia. In concluding the discussion in this section it will be beneficial to show a map of land use classification of Indonesia, particularly of Java and Sumatra, where development of forest industry is relatively advanced, as in Fig. 3. A typical land use classification by elevation is illustrated in Fig. 4.

Fig. 3 Land Use Classification in Indonesia



Note: Maps of land use classification in Indonesia with detailed information are available. For this report, however, only the outline of land use was introduced. The map used for this purpose is the Senior Atlas For Malaysia and Singapore, by George Philip And Son Limited, London 1967.

Fig. 4 Graphical Illustration of Land Use Classification in Indonesia (Part of Java and Sumatra)



Now, what historical background and relations have brought the present state of land use?

Historical background in relation to the present land use may sufficiently find its origin in the period of Dutch colonization. In the following discussion this period will be divided largely into the period from Dutch colonization to independence of the country (to the end of World War II) and the period from immediately after the end of the war to the present. We shall begin our discussion with the former.

a. First Stage (From the day of Dutch colonization to the independence)

In the 17th Century Holland extended her power to Indonesia centering on Java.

As the country came under the control of Holland, the economy of Indonesia shifted from the agriculture centering on the production of rice to the agriculture for the production of peppers and indigo, both of which were the main items of trade then, at first and the cultivation of coffee was encouraged at a later stage.

This shift from the rice-centered agriculture was carried out compulsorily by the authorities with suppression of farmer's resistance.

With the coffee, for example, the people of Java, as a matter of course were not willing to cultivate such a perennial crop which they had never seen or heard about. It is said, however, that the cultivation of coffee was started in 1785 as a compulsory crop and the farmers who were allocated the designated number of coffee plants had no other choice but to cultivate them(4).

Since the beginning of the 19th century trial cultivation began with tea (around 1825), teak (around 1849), oil palm (around 1853) and rubber (around 1864).

We shall touch briefly on the teak plantation in Indonesia in view of the nature of this report.

It may be said that the full-fledged management of teak plantation in Indonesia began in 1808 when the Regional Forestry Department was established in Semarang of the Central Java. It was followed by the introduction of German forestry techniques in 1849, which resulted in the silviculture of teak wood by seeding incorporating true forestry techniques. And in 1874, forest was classified into teak forest and copse, by which the structure of the operation and management of teak plantation was firmly established.

The technique used for the silviculture of teak wood until about 1880 was such that the forest ground was burned and cleaned after cutting and teak seeds were sown with the use of a guide rod or merely broadcast. In 1883, however, the Taungya method was adopted in Pekalongan of the Central Java and this method was continuously used until 1907(5). In the following year, in 1908, the Taungya method was added with another technique which enabled the plantation of Leucaenua glauca in mixture with teak and the technique of silviculture of teak by seeding in Java was firmly established. At the same time the spread of the Taungya method made the silviculture of teak economically payable.

In the following section we shall touch briefly on the Taungya method.

The Taungya method is a method of intercropping within the forest. On Java Island which suffers from an over population the land available for cultivation is relatively small and therefore the farmers earn their living by raising maize and upland rice in the forest area leased by the government. In return the farmers must be engaged in silviculture and weeding of the forest for the government.

The period of the Taungya method is generally used for 2 to 3 years during which weeding is required.

With this method no cost is required for silviculture other than the costs of seedlings and because of this fact the forest industry with its low productivity can survive economically.

At present the Taungya method is used for silviculture of not only teak but also other tree species in Java.

From the above discussion we can see a concrete example of the fact that the existence of agriculture is one of the essential conditions for the existence of forest industry even with its low productivity.

Any way, the present system of land use has its origin in the day of Dutch colony and followed the course to the present state. Table 6 below shows an outline of land use in Indonesia prior to the end of the era of colonization.

Table 6 Main Export Items of Agricultural Products

Product	Total export of the world (ton)	Export of Indonesia (ton)	Percentage (%)
Cinchona	12,445	11,183	90
Kapok	25,203	15,956	63
Pepper	64,094	54,502	85
Rubber	910 (MT)	303 (MT)	33
Copra (others)	2,021 (MT)	590 (MT)	29
Palm oil (others)	1,192 (MT)	268 (MT)	22
Tea	29,409 (MT)	1,399 (MT)	5
Coffee	1,763 (MT)	68 (MT)	4

The teak plantation expanded to about 800,000 ha (natural forest included) in 1935.

b. Second Phase (From the year of independence to the present)

During the period from 1941 to 1945 when the country was under the control of the Japanese military regime emphasis was placed on the self-sufficiency of food and the estates other than those of high productivity were left unattended.

Again, due to the Independence War that lasted until the end of 1947, the estate was laid waste and the sugar and tobacco plantations were also turned to the land for food production.

As a result of a round table conference with the Dutch representatives held in the Hague in 1947, Indonesia won her independence and moreover, as a result of amicable agreement, private properties of Dutch nationals in Indonesia were guaranteed. In other words, the rights and interests of the Dutch enterprises which existed prior to the Independence War were officially recognized by the Indonesian Government as they were in former days.

Consequently, the estate seemed to have been rehabilitated to its former state and made a good start toward smooth progress of operation.

However, after 1959 when the Sukarno Administration began taking an anti-west attitude the western capital was gradually expelled from the estate and the national capital seized the control of the estate. It was hardly possible, however, for military personnel or government officials appointed to the management post to carry out the management of the estate effectively. It was not likely, in the same sense, that the sale of confiscated estate to private sector resulted in satisfactory management because of lack of capital and inefficient techniques.

On the other hand, the irresponsible financial policy of the Sukarno Administration, which gave priority to the politics, resulted in the aggravation of the inflation and as a result, the estate again went to ruin.

In 1966 when Suharto came into power replacing the Sukarno Administration, the government began to incline toward liberalism with the expectation of financial aid from the West.

Its economic policy abandoned the industry-priority attitude which had been taken by the Sukarno Administration and was based on the "Theory of Gradual Progress" advocated by Mr. Mohamed Hatta which places emphasis on agricultural production rather than the rapid industrialization and plans gradual progress of industrialization. It may be said that such a concept is quite reasonable and acceptable.

This concept is reflected in details in the Five-Year Development Project which was inaugurated in April 1969. The project gives priority to[6] (1) the production of foodstuffs and export items (agricultural and mineral), (2) foreign exchange policies (3) employment measures, and (4) improvement of technical level of manpower. In addition, the government granted the reinstatement of part of Western enterprises.

Even today in 1970 the devastation of the estate can still be seen in part and the seriousness of the damage it has received in the past is reorganized.

Now, what course the forest industry has taken during this period (from the day of independence to the present)?

In sharp contrast to the devastation or stalemate of the estate, the development of forest industry (includings cutting in addition to silviculture) has made a smooth progress.

Main reason for this development may be found in the following points.

(1) Forest product is one of the important trade items to earn foreign exchange.

(2) Demands for lumber are very strong not only in Indonesia but also in foreign countries including Japan.

(3) Development (cutting) of natural forest does not require a large capital investment as compared with artificial silviculture.

Any way, full-fledged silviculture of trees other than teak which requires relatively a large amount of investment in the development of forest industry also began in the post war period.

As mentioned previously, the silviculture of such tree species is being carried out centering on Java and Sumatra.

The question here is that while the existence of silviculture in Java is understandable in view of the availability of the Taungya method which is only possible with a large population in addition to the above given reasons, where the energy for silviculture can be obtained in Sumatra where the Taungya method is not available.

This question may be answered when one looks into the source of the capital.

Not only in Sumatra but also in Indonesia as a whole the costs of forest regeneration and the expense for the construction of forest roads under the jurisdiction of local agencies are covered by subsidies from the Indonesia Government Treasury and funds provided by local provinces.

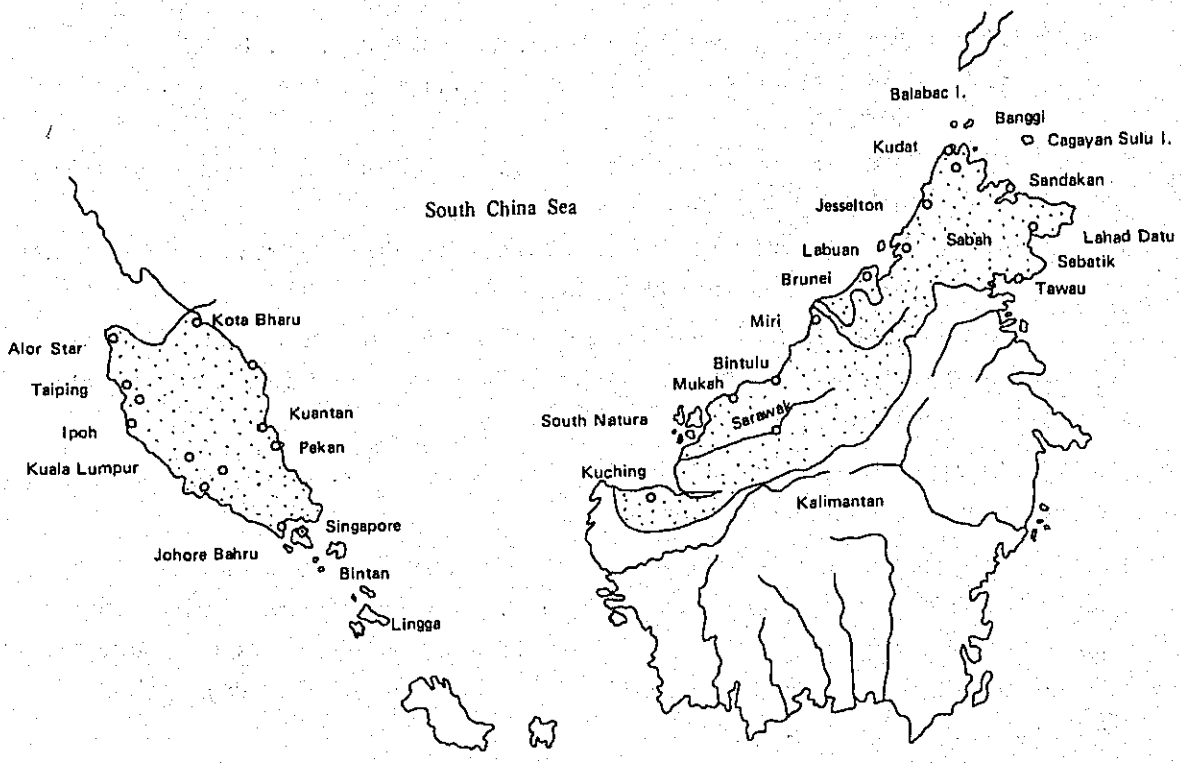
In the case of Sumatra development of the primary industry such as agriculture is far advanced compared with other regions of Indonesia and therefore the fund required for the development of forest industry is larger than in other regions.

This is the main reason for the powerful energy that supports silviculture in Sumatra.

2-3 Economic Development and Land Use in Malaysia

Malaysia, which won her independence on September 16, 1963, comprises the south portion of the Malay Peninsula (called West Malaysia comprising 11 provinces following the separation and independence of Singapore in 1965), Sarawak in north part of Borneo and Suvah Province. The total land area is 33,100,000 ha (of this 13,000,000 ha is in West Malaysia), which is equivalent to about 90% of the total land area of Japan. The population is approximately 9,240,000 (of which 7,920,000 is in West Malaysia).

Fig. 5 Map of Malaysia



A study of economic structure of Malaysia in terms of component ratio by industry origin (1967) shows[7] that agriculture and fishery accounts for 27.8% (of which rubber industry alone accounts for 12.1%), manufacturing industry accounts for 11.4% and wholesale and retail sector accounts for 15.8%, indicating greater weight of the primary industry (However, as seen from per capital income the rate of economic growth is exceptionally high compared with that of other Southeast Asian countries).

It may be said, therefore, that the economic growth of Malaysia is still in the stage of an agricultural country.

Now, let us look into the state of land use in agriculture on in the primary industry in a broad sense, which holds and will hold an important position in the economy of the country for sometime in the future.

Here, we shall have a glimpse of an example of West Malaysia which has the most advance form of development in the country[8]. (To attain our objective of obtaining detailed information on the status of land use in the primary industry in relation to the economic growth and the way the primary industry should follow in planning land use, it will be more appropriate to limit our observation to West Malaysia, the most advanced region in the country).

According to the 1965 statistics, the total land area under cultivation is 6,500,000 acres, of which 4,340,000 acres is for rubber plantation (67%), 700,000 acres for tea

garden (11%) and 500,000 acres for palm tree plantation (5%), indicating an overwhelmingly large share of rubber plantation (Rubber production in 1965 was approximately 910,000 tons, accounting for more than 1/3 of the total rubber production in the world).

A study on the ownership of rubber plantations shows that the Estate (rubber plantation of more than 100 acre in area) owns 1,800,000 acres (41% of the total area of rubber plantation), which is equally divided into halves, one in the hand of European Nationals (mainly the United Kingdom) and the other in the hand of Chinese nationals. The land owned by small scale farmers (less than 100 acres in area) is 2,530,000 acre, which is equally divided into halves, one in the hand of Chinese nationals and the other in the hand of Malayan. This shows clearly that about 1/4 of the total rubber plantation is under the control of the western capital. Furthermore, the shift to oil palm plantation (rubber production is still the main industry and shifting to oil palm plantation is done by opening new land in most cases), now in progress to counter world-wide stagnation of rubber market, is also centered on the Estate under European capital (in the case of oil palm plantation, appropriate scale is said to be more than 2,000 acres).

In contrast to this, the production of rice and coco palm has become the main trade of the Malayan. Upon completion of the "Muda River Project" which is now in progress, it is expected that self-sufficiency of rice will be achieved in the first half of the 1970's.

Another important aspect of land use is the production of tin. Tin is the most important product together with rubber for the economy of the country (production of tin in 1965 was approximately 62,000 tons, accounting for about 30% of the world production. And combined production of rubber and tin accounts for more than 90% of the revenue from export custom duties and that of tin alone accounts for 10 to 20% of the revenue from export custom duties).

Of the 72 stannaries employing a modern dredger system, 71 are owned by Western countries and the production is shared by Western capital which accounts for 60% and the Chinese capital, accounting for 40%. And the two tin smelting works are also under the control of British capital.

Finally, we shall touch on forest industry in Malaysia.

The total forest area of West Malaysia is 8,810,000 ha, accounting for about 68% of the total land area. Of the total forest area, the commercial forest accounts for only 25%. As in the case of other Southeast Asia countries, forest in this country is also under the ownership and control of the government.

The regeneration methods now employed in West Malaysia are the natural regeneration method called "The Malayan Uniform System" (a sort of selective cutting method) and the artificial regeneration method.

The artificial regeneration method includes Enrichment planting (planting in the area where the result of natural regeneration is not satisfactory by cutting through the forest in a straight line. Details will be given in Chapter III) and ordinary silviculture method.

Regeneration of the forest with the use of the former totaled 820 acres in Malanty and Kapole in 1966.

Silviculture is the most expensive method for the regeneration of forest. Therefore, the fact that this method is actually employed in this country is the parameter indicating the possibility of further growth of forest industry in this country.

Regeneration of pines (Pinus caribaea, P. insularis and P. merkusii) began in 1956. As the silviculture is one of the enterprises of low productivity, comparative studies on the silviculture and the natural regeneration method have been made in Selangor Province. In 1966, silviculture of caribbean pines was accomplished in the forest reserves in Ulu Langat and Rantau Panjang in an area of 194 acres. In Selangor province a total of 844 acres of pine plantation was created by 1966.

In each of Pahang and Negri Sembilan provinces a pine nursery covering an area of 24 acres has been provided, respectively.

Beside the silviculture of pines, a plantation of teak has been created in an area of 205.5 acres in the Mata Ayer Forest Reserve. It is of great interest to note that this plantation has been created with the use of the Taungya System as in the case of Java in Indonesia.

A plantation of Jelutong (Dyera costulata) has also been created in an area of 26 acres in the Sungei Buloh Forest Reserve (This will be expanded to at least 1,000 acres in the future) in Selangor province.

Jelutong is used for the manufacture of pencils, modeling and wood working, and the latex is used as raw material for the manufacture of chewing gum.

As has been seen in the past discussion, the development of forest industry in West Malaysia began after the end of World War II and it seems that the progress of forest industry is rather slow compared with the tempo of the economic growth (This point will be discussed further at a later stage).

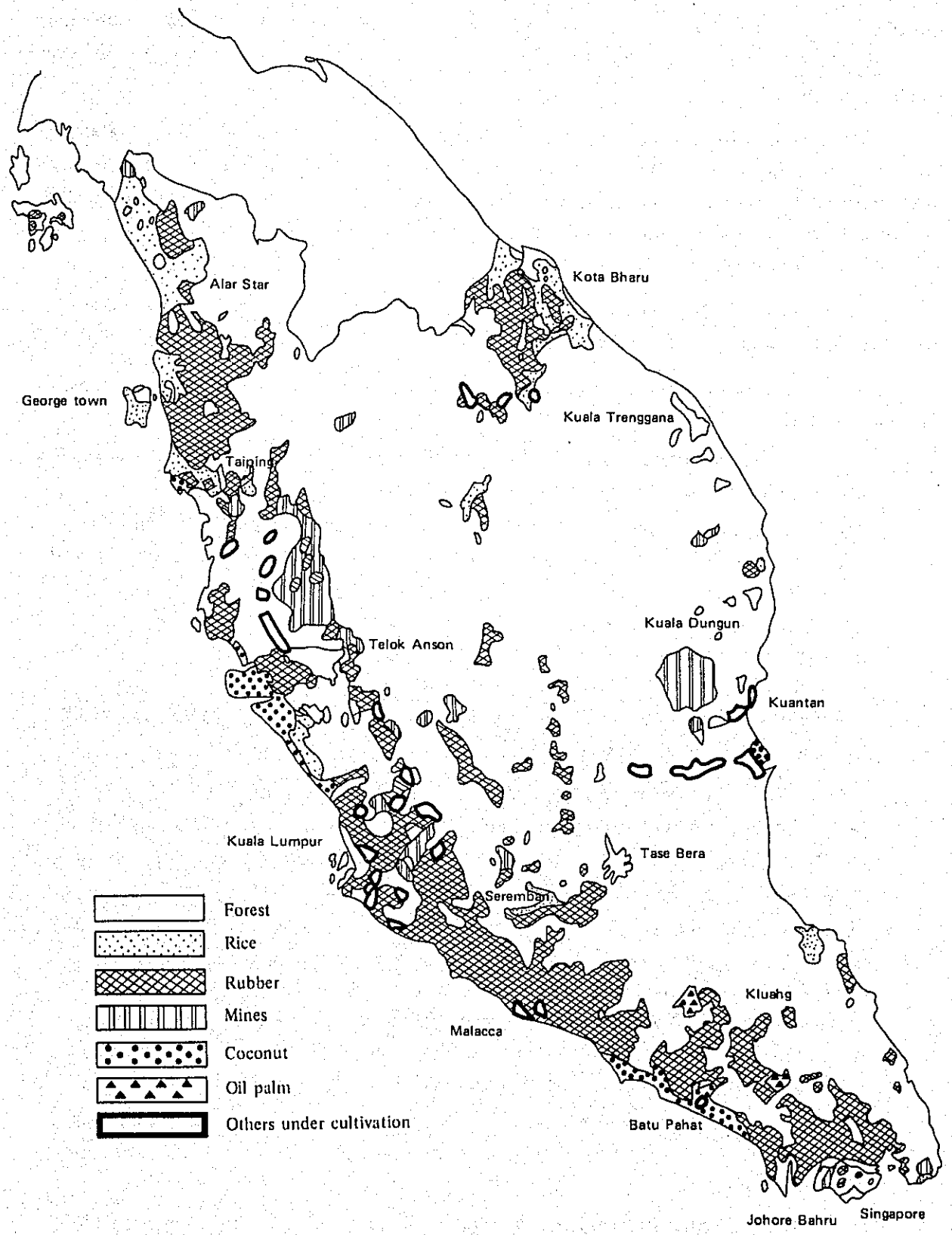
Anyway, the above is the picture of the position of the primary industry and the present state of land use in the country (West Malaysia).

Now, before discussing the historical background which brought about the present state, it may be advisable in a sense of summarizing the discussion to illustrate land use in West Malaysia as shown in Fig. 6 below.

As for the land use classification by elevation, it may be said that it is almost similar to that shown in Fig. 4 but the difference is that forests are seen in the land 300 to 500 meters above sea-level and that rubber plantation is dominant in the flat land below this elevation.

In the following section we shall see into the historical background of Malaysia.

Fig. 6 Land Use Classification in Malaysia



England gained the possession of Singapore, Malacca and Penan as crown colonies in 1867 and set up the former (old) Federal of Malaysia in 1895. With the annexation of four northern provinces formerly possessed by Thailand in 1909 and the Johore Province in 1914, the British possessed Malay was born. With the annexation of Sabah and Sarawak provinces in 1963, Malaysia came into being (As stated previously, Singapore was separated and because independent in 1965).

Under the British control as a colony for about a century and a half, West Malaysia was brought up as a typical monocultural country (inclination toward international commodities, particularly those products in scarcity), taking full advantage of natural conditions and strictly adhering to the production of rubber, rice and tin (In this respect Malaysia is more extreme than Indonesia).

The course of Malaysia has not deviated greatly from this course during the period from her independence in 1957, following the end of World War II, to the present day.

There have been, of course, some changes. Some of the characteristics and changes in land use during this period may be pointed out as follows.

(1) While Indonesia attempted to expell foreign capital from the estate after she gained independence, Malaysia has never attempted such a move.

(2) Malaysia did not follow such radical policies toward rapid industrialization as taken by Indonesia, more accurately, under the Sukarno Administration but instead she followed the policy of gradual economic growth. Therefore, emphasis is still placed on the development of agriculture, more accurately, on the development of the primary industry as a whole (This is clearly indicated in Land Development in Malaysia Under the Federal Land Development Authority – Description of Programme and Techniques of Development Implementation By Jan Sri Bin Haji Andak, Chairman, Federal Land Development Authority Malaysia, Oct., 1966).

(3) As a result, devastation of the estate is not seen in this country.

(4) Under these conditions the country was able to attain relatively large accumulation of capital, which in turn helped smooth shifting to more profitable oil palm estate, thus taking lead in the move of other Southeast Asia countries.

(5) Additionally, by planning extensive cultivation of diversified crops such as tapioca, maize, cocoa, sugar cane and tea, the country attempts to materialize diversification of agriculture, in other words, the country is making an all out effort to surmount the monocultural structure of agriculture in the past (This means an attempt to escape from the economy solely supported by rubber and tin, which are subject to constant economic fluctuations).

(6) Attention has now been shifting from the development of low land to the development of hill land (1,000 feet or more above sea-level) and plans are being put into practice.

In developing hill land it is natural that the priority must be given to the development of forest industry. This means that the positive development of forest

industry was initiated only after the war (This can be affirmed realistically from the aforementioned progress of silviculture).

The negative factor for the full-fledged development of forest industry after the war is the fact that the economy in this country was adequately supported by the monocultural economic structure centering on the production of rubber and tin and that these items had higher productivity than lumber production. As already mentioned in the section for Indonesia, the positive factors in the case of this country are:

a. Generally speaking, the country is making efforts in an attempt to surmount the monocultural structure.

b. Demands for lumber have increased considerably in and out of the country.

c. As a result, it was possible to market forest resources under favorable conditions and realize capital accumulation.

d. As seen in the case of teak plantation (The Taungya system, for example), agriculture holds a firm position as a source of manpower (Generally speaking, this is a prerequisite to the procurement of low wage labor).

It is believed that through the past analysis one was able to see in detail the relationship between the general economy and agriculture and additionally, the correlation in the development of agriculture and forest industry.

The foregoing analysis may be summarized as follows with the addition of the comment on the way the economy of a country should follow from the stand point of efficiency in the economic development.

(1) In attempting the growth of economy, industrialization must always be considered in relation to the growth of the primary industry.

(2) Within the primary industry substantiation of agriculture must be attempted at first and the full-scale development of forest industry must be planned in proportion to the settlement of farmers (Conversely speaking, full scale development of forest industry can not be expected unless this condition is fulfilled).

Land use pattern by elevation in Southeast Asia countries is shown in Fig. 4. The development of land, as a matter of course, must begin with low land and then extend to hill land.

(3) Foreign capital should also be introduced as the condition permit.

(4) The theory of development that has been consistent throughout the past discussions is, in general terms, that the procurement and accumulation of capital and labor must be accomplished within the framework of domestic economy as a rule.

2-4 Development of Economy and Forest Industry in Cambodia's Coast Area

2-4-1 Description and characteristics of the coast area

The economic condition of Cambodia as a whole may be justy said to be in a fair way to the development centering around agriculture and forest industry (Farming population accounts for 81% of the total population and agricultural income accounts for 41% of the GNP).

Present land use in the country is shown in Table 7 below.

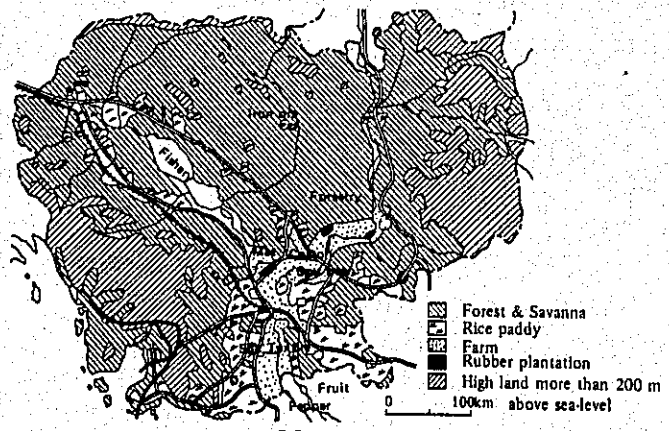
Table 7 State of Land Use in Cambodia

Land Use Classification		Area (1,000 ha)	Ratio %	Ratio %
Land under cultivation	Rice paddy	2,493	85	14
	Other annual crops	230	8	1
	Orchard	1		
	Rubber plantation	39	1	
	Other crops	58	2	
	Shifting cultivation	116	4	1
	Subtotal	2,937	100	16
Land not under cultivation (Such as savanna)		1,801		10
Forest		13,372		74
Total		18,110		100

According to the above table, forest accounts for 74%, non-cultivated land such as savanna and marshes for 10% and the land under cultivation accounts for 16% of the total land area of the country.

The land under cultivation may be further broken down to major land use such as rice paddy with a total area of 2,490,000 ha, accounting for 14%, other annual crops cultivation land with 230,000 ha, accounting for 8% and rubber plantation with a total area of 40,000 ha. accounting for 1%.

Fig. 7 Land Use Classification in Cambodia



It is evident that land use in this country is lagging far behind other countries.

This lag is mainly attributable to the colonial policy of the French Government.

France started its colonization scheme of Indochina in Vietnam and placed it under her control in 1883 and then colonized Cambodia and Laos in that order.

From this historical process it is evident that France began establishing her influence in the land of most favorable economic conditions and continued her investment in Indochina, mainly in Vietnam, until the collapse of her domination over the colonies after the end of World War II. In the end, there was no appreciable accumulation of French capital in Cambodia and Laos (This is particularly true with Laos).

In Cambodia the only result of French investment in respect of land use may be seen in a rubber plantation covering an area of 40,000 ha. in Kompong Cham Province.

The above is a general description of the development of economy and land use in Cambodia as a whole.

As seen in our discussion in Section 2-1-3, it will be necessary for Cambodia, which is in such a position as described above, to make an all-out effort for the development of the primary industry by placing emphasis on agriculture for the time being and for the steady increase of domestic capital accumulation and at the same time to allow investment of foreign capitals and accept aid from other countries as long as they do not bring about harmful effect on the politics. It will also important for her to make an all-out effort for the rearing (education) of her people who will be the support and driving force of the future development.

It is a pity that this country has been following a very unstable foreign policy, the so-called "Rope-dancing foreign policy" (How can anyone imagine a better foreign policy than this in this country?) because of her weak economic power. However, she has been following the course to the economic growth as described above, even though her course had many ups and downs. (This is exemplified by the growth of annual per capita income, remarkable spread of education and the Mekong Development Project by FAO).

In the past we have discussed the question of economic development of Cambodia as a whole. Now, let us turn our eyes to the coast area which is the focal point of this report.

As shown in Fig. 7, the coast area referred to here is the area surrounded by Cardamome, the Elephant Range and Siam Bay.

This region, inspite of its importance as being the only region facing the sea in Cambodia, has remained as one of the most backward regions in the country.

As stated previously, this was due to the fact that the development of French Indochina was carried out mainly in Vietnam and that the priority in the development of Cambodia was given to the Mekong River which was conveniently located for sea transportation.

In discussing the economy and the development of forest industry in the coast area, the main subject of our discussion, it is considered appropriate to divide the area largely into three groups, according to the economic structure and the degree of development. They are the area centering on Kompong-som (Compong-som district), Kirirom district and other district (to be called as Chruoy-smach district).

2-4-2 Development of economy and forest industry

2-4-2-1 Kompong-som District

This is a fan-shaped area extending from the Kompong-som Port as its pivot.

The port of Kompong-som is the only outer port in Cambodia and was constructed during a period of 1955 through 1965 under financial and technical assistance of France.

Port facilities include a pier 185 meter long and 10 meter wide, which is capable to accommodate four vessels, and two warehouse buildings. The depth of the water on the ocean side of the pier is 10 meters and that of on the other side of the pier measures 8 meters.

From the Kompong-som Port an excellent highway leads to Phnom-penh and the two cities are within the reach in about three and a half hours by car.

A plan is also being worked out to develop the port as a free port.

As seen from the above description, the Kompong-som district is the most developed area among the three districts and possesses the potentiality of further development. However, the major portion of the hinter land extending from Kompong-som Port in a fan-shape is covered with forest and the development of this region must yet been seen.

We shall make a brief comment on the land use project for this district in the following section.

As we have advocated in our discussions in the sections following 2-1, what must be done first in planning land use in the hinterland is to attempt the development of agriculture and settlement of farmers.

In this case, both the estate (participation of foreign capital is conceival) and resident farmers (small scale) must be chosen as the bearer of the responsibility for implementing this scheme, as in the case of Indonesia and Malaysia. Main crops to be cultivated will be oil palm and coco palm for the former and coco palm and rice for the latter.

The next step to be taken is the development of forest industry.

The concept of developing forest industry in this district will be as follows.

(1) The forest which can be converted to farm land (except forest reserves) should be released to private sectors as farm land. In this case clear cutting of forest must be accomplished at first. Efforts should be made to utilize the fallen trees for lumber and pulp wood to the extent possible depending on the quality of trees.

(2) In this case, the forest which is essential to the existence of resident farmers should be sold to them.

(3) With the development of agriculture and the settlement of farmers, more intensive management may be expected for the forest located in the back of farm land.

The regeneration technique employed in this area will evolve from the present silviculture the artificial silviculture, particularly from the enrichment planting to general silviculture, depending on the progress of agricultural development and the economy of Cambodia which is expected to grow steadily.

Under present conditions, the implementation of artificial silviculture on an extensive scale is not considered justifiable even in this district from an economic point of view.

(4) This concept is based on the fact that in the forest industry, unlike other modern industries, innovation of production technique can not play a leading role in the development of the industry, or conversely speaking, there is an understanding that the technique to be employed is determined depending on such factor as the level of economic growth surrounding the forest industry.

(5) As mentioned previously, however, it may be said that there is a possibility of future adoption of more intensive silviculture techniques in view of the potentiality for the development of this district. Therefore, "further" efforts should be made for the study on the intensive silviculture techniques, even though it may not be possible to invest a large amount of capital at one time. (The reference to "further" was used because studies in this field have already started in this country with the establishment of a forestry experiment station in Kompong-chaum Province).

(6) It is needless to say that the extent of forest area to be retained as the forest in this district must be determined in correlation with the agricultural project. However, it is natural that not the all forests are to be managed with the intensive techniques of the same level but are to be treated according to the degree of differences in the economy and natural conditions in each district.

2-4-2-2 Kirirom District

This district covers an area of approximately 18,000 ha, of which about 13,000 ha is occupied by pine forests (estimated volume of 2 million m^3), about 3,000 ha by broad-leaved forest and 2,000 ha by farm land (tea garden) and ornamental plantations.

As stated above, this district has many excellent pine forests which are believed to have grown naturally in an extensively wide area after the shifting cultivation. This is the main reason for taking up this district as a special district.

We shall begin our discussion with the land use plan and deal with the problems associated with the plan at a later stage.

(1) Being situated in the high land 500 to 600 above sea-level, the district is favored by fine weather and has many scenic attractions. Therefore, it may advisable to retain some portions of the existing forest area as a scenic zone. It is also conceivable to retain part of the broad-leaved forest now in existence in the form of natural forest as a scenic zone or a forest reserve for the protection of wild animals instead of converting the entire portion of it to a pine forest.

(2) At present tea gardens are seen in some part of the district, which are being operated under financial and technical aid of the Communist China. Frankly speaking, these tea gardens do not seem to be a great success.

However, as repeatedly mentioned in the past, it is important for regional development to plan an effective utilization of land as a farm where it is possible and to encourage the settlement of farmers at the farm land.

For this reason, further efforts should be made in this respect.

(3) As mentioned previously, the pine forests possess excellent rich lumber resources. With the well-planned cutting of these forests, and the investment of capitals, accrued revenue from the sale of pine lumber, it will be possible to realize continued regeneration of forest by means of natural regeneration or artificial silviculture.

However, in order to work out effective cutting and regeneration programs backed by concrete financial plans, it is urgent to establish regeneration techniques closely related with the intensity and the method of cutting (Detailed discussions in relation to this subject have been made in Chapter III).

(4) Concerning the natural broad-leaved forest, it will be advisable to refrain from hasty conversion to pine forest for the time being unless some progresses are made on the study of the technical aspect.

And, as mentioned previously, it will also be advisable to utilize part of these forests as scenic zones and forest reserves for the protection of wild life.

The above is the main idea of the land use project for Kirirom district but the planning and implementation of this project involve major problems.

One of the problems, needless to say, is the fact that no satisfactory techniques in the management of pine forest. (Integrated techniques of cutting and regeneration) have been established and the other is the low level of the economic condition in the country.

Apart from the former which does not require detailed explanation, we shall only touch on the latter briefly.

In Cambodia, 7% of the total revenue from forest industry is returned to the National Treasury and for this reason, the past reinvestment in the forest industry can not be said to have been adequate. This situation, however, may have been unavoidable when the destituted economy of the country is taken into consideration. One can not but acknowledge the fact that this will be a major obstacle to the implementation of expanded regeneration programs in forest industry.

2-4-2-3 Chruoy-smach District

The Chruoy-smach district is the largest of the three coast districts and covers an area of approximately 580,000 ha. Most of the district are covered with forests and the lumber resources is also abundant. However, due to extremely poor traffic conditions (Not accessible over land) and the resultant low standard of living, the district is lagging far behind in the development. At present, only SOKECIA (a Japan-Cambodia joint-venture) is engaged in the planless lumber production with the aim of exploiting a forest covering an area of approximately 16,000 ha (this forest lot is a ten-year lot up to 1975 and 20,000 m^3 of lumber is being produced annually) in and around Chruoy-smach district.

Under these conditions of transportation and living standard it may be difficult to adopt any systems other than the most extensive (planless) development method with which only usable trees of large diameters such as Koki phnong, Chhoeuteal and Phdick are selectively cut down as far as the management of forest is planned on commercial base.

Consequently, for the silviculture techniques which possess essentially the subordinate nature, more intensive techniques such as enrichment planting (details of this technique shall be dealt with in the following Chapter III) which is adopted in Indonesia or such techniques as aritificial silviculture cannot be conceived at least on the commercial base.

In order to introduce such intensive silviculture method as mentioned above for practical purpose, there must be such conditions as the assurance for the procurement of capitals for the adoption of regeneration technique through marketing of lumber of large diameters at an exorbitant price or economical utilization of timbers of the types which have so far been not utilized, and the availability of manpower at relatively low cost.

Now, let us probe into the measures which are conceivable for this district for the time being.

One of the measures conceivable is the utilization of timbers of various types which have not been utilized so far because of their small diameters.

On this question, it may be advisable to refer to the situation in Japan (This does not mean Japan is the only country capable to carry out this project. The case in Japan is quoted only as an example).

The main factors for the survival in the competition in Japan's pulp and paper industry (hereinafter referred to as the pulp and paper industry) are the control of market and the availability of stabilized supply of raw wood and moderate prices.

We shall limit our discussion to the latter in view of the subject of this report.

Reflecting the shortage of coniferous timber in the first half of the 1950's, the pulp and paper industry in Japan suffered from spiralling prices of coniferous timber in the period to follow. Under such conditions each firm of the industry challenged the situation with technical innovation and found a way to overcome difficulties by shifting the source of raw wood supply from coniferous timber to the lower priced broad-leaved timber. Compelled again by the shortage of raw wood supply, which because serious around 1961, the industry further advanced its technology for the utilization of tips.

In recent years, technologies have so advanced that various coniferous timber of small and medium diameters, which are left untouched in the forest in Southeast Asian countries, can be effectively utilized.

Thus, untouched coniferous timber of small and medium diameters in the forest of Cambodia has moved into the limelight as the object of pulp and paper industry of Japan.

With the progress of development in the utilization of coniferous timber of small and medium diameter, left untouched in the forest of Chruoy-smach district and with the capital accumulation made possible by the revenue from the sale of timber, it seems as if there is a possibility for employing intensive management techniques.

However, the question is not so simple. This is because the present pier facility can not accommodate ships of only 3,000 to 5,000 tonnage and as a result, the loading must be accomplished with the use of barges.

This type of management may be paying when the lumber of only large diameters are handled because of their high value. In the case of low priced pulp wood, however, loading with the use of barges will result in an excessive increase in the cost and the enterprise will not pay even when the pulp wood is provided free of charge (As there is a potentiality in the Kompong-som district, employment of intensive techniques may be expected). Moreover, investment of 700 to 1,000 million yen in the construction of piers is beyond the capability of private enterprises when the profitability is taken into consideration.

Thus, the development of the coast area, which seemed to have breakthrough of its barrier with the capital participation of the pulp and paper industry, will have to face another major obstacle.

Therefore, it may be said that the question of developing Chruoy-smach district is the one that precedes the question of techniques (This does not mean

the technique is not an important factor and it is needless to say that studies must be made on the technique as early as possible, because it will take a long time to establish techniques which may be required immediately when there is an opportunity for the development in view of its nature).

Therefore, if possible development of forest industry is to be planned for Chruoy-smach district of Cambodia from a long-range viewpoint, there must be such economic and technical assistance as previously described provided on the balanced base.

Otherwise, it must be concluded that the mere technical assistance may result in only the castles in the air when the present condition in Cambodia is taken into consideration.

Now, for the establishment of agriculture as a means of development of Chruoy-smach district, the growth of agriculture may be, indeed, the one step for the development in that it accumulates capital and supplies stabilized labor force, as we have already discussed. Dependence on agriculture for the development in Kompong-som district but it will be extremely difficult to apply this concept to Chruoy-smach district judging from various reasons.

If this concept is to be put into practice, it will probably be taken up as part of the national policy necessitated by national defense or national development project.

Notes:

(1) (1) R. Nurkse, Problems Capital Formation in Underdeveloped Countries 1953

(2) G. Myrdol Economic Theory and Underdeveloped Regions 1957

(2) Hisao Nishioka; Location condition and Regional Economy 1963, Page 110 111, Published by Miyai Book Store

(3) Kashima Peace Research Institute; Basic Concept of Development, 1967, Page 38 41

(4) Kashima Peace Research Institute; Indonesia, page 11

(5) Tsutomu Shioya; Development of Silviculture in Southeast Asia, Page 253

(6) Takeharu Sasamoto; Asia is moving, Published by Japan Tariff Association, 1970, page 43-44

(7) Same as above, page 100-101

(8) Same as above, page 100-101

CHAPTER III. REGENERATION OF FORESTS IN THE COAST AREA

3-1 Outline of Forest in Low Land of Coast Area

3-1-1 Natural Conditions

This district belongs to the so-called "Tropical rain forest zone". Climatic conditions in this district in comparison with that of other areas is shown in Fig. 8 and 9[2) 3) 4)].

Fig. 8 shows the Walter's climatic diagram[1)] in which the monthly mean temperature and the monthly precipitation are shown in the longitudinal axis so that the temperature of 10°C and the precipitation of 20 mm come to the same point.

Fig. 8 Comparison of Climate Between the Coast Area and Other Parts of the Country

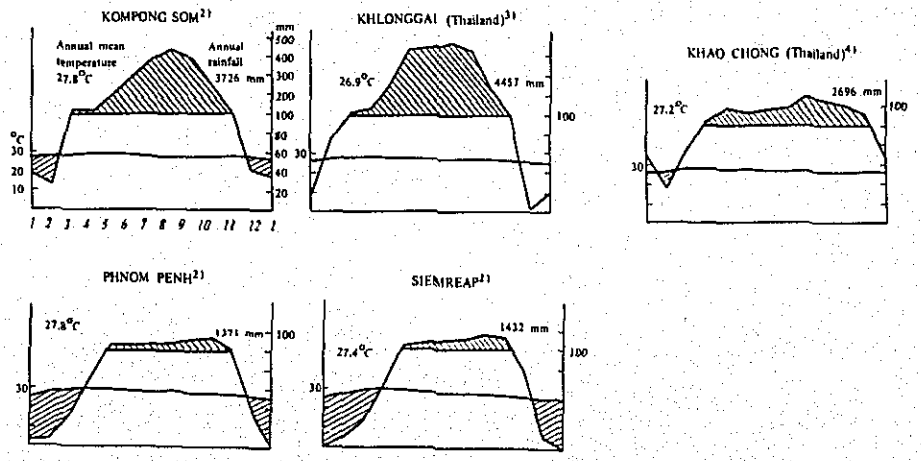
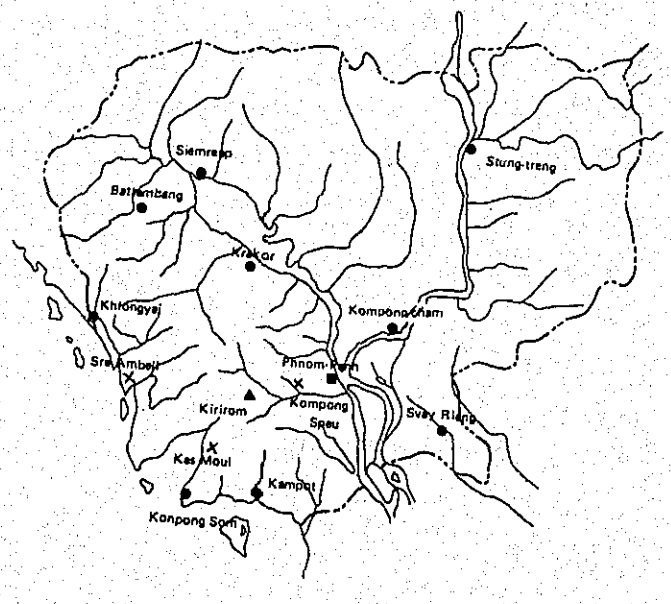


Fig. 9 Map of Cambodia



Furthermore, the precipitation of over 100 mm is shown on the scale of 1/10. The portion where the precipitation curve comes below the temperature curve in the annual fluctuation curve is the so-called "Walter's dry season".

By taking the weather conditions in Kompong som and Khlongyai on the south tip of Thailand as a typical examples of the climate in the coast area, the annual precipitations are about 3,730 mm and 4,460 mm respectively, which are considered to be extremely high rate, but annual distribution of the precipitation is quite irregular and create the 3 month dry season (December - February) and 2 month dry season (December - January).

Even with the theory which defines dry season as the season with the monthly precipitation of less than 50 mm, there still is a two to three month dry season. Further, the annual precipitations in Sre Ambell facing Gulf of Siam and Kas Moul deep in Kompong som Bay are 2,940 mm and 3,725 mm respectively and the dry season with the monthly precipitation of less than 50 mm extends to 3 or 4 months in these districts. In Khao Chong, a Thai territory in the Malay Peninsula, the annual precipitation is such low as about 2,700 mm but the seasonal distribution of precipitation is fairly even and the dry season is only one-month duration in February.

The effects of these dry seasons are reflected in the structure and composition of forests in the low land coast area of Cambodia and the humid forest in the low land of Cambodias coast area are much poorer than the typical tripical rain forest in the Malay Peninsula. This compares with Phnom-penh and Siemreap, inland area of the country, where the temperature is almost the same but the precipitation is far less and the duration of dry season is four months. The forests in these two regions are mostly dry forests or semi-humid forests.

The topography of the coast area extending to the foot of the Cardamome ranges and the Elephant ranges is a gently sloped undulating hill and the parent rock consisting of sandstones which belong to the Mesozoic Korat series. The height difference between ridges and valleys is only several tens meters and open shallow valley extends along the meandering river.

3-1-2 Type of Forest

Major forests in low land coast area may be classified into three categories according to the standard classification method of Cambodia, namely, (A) Humid forest, (B) Dwarf forest and (C) Rear mangrove.[5)]

(A) Humid forest

The humid forest is also called as the tropical rain forest and is seen in the flat surface of hills where soil depth is great. As a general feature of the tropical rain forest, the upper story of the forest is formed by intermittent canopy of huge trees (The first high tree story, the huge tree story) and the lower story or the second story is formed by dense and continuous canopy.

In the region affected by the dry season, however, the growth of tropical rain forest is much slower and the simplicity in the tree species, low density of the first high tree story and the decrease in the height of high tree story are generally seen[4) 6)].

As stated previously, there is a definite dry season, though short in period, in the coast area of Cambodia and it is unavoidable for the forests to come under its influence.

The humid forests in this district are formed by the intermittent canopy of first story of about 35 m to 45 m high and dense second story of about 15 m to 20 m high. Compared with the scale of fully grown humid forest of Borneo and other regions[6)] (The first story being 60 m high and the second story being 20 to 30 m high) it is evident that the growth of forest in this area is not satisfactory.

On the number of tree species the survey in Cheko[4)] showed 37 tree species having a diameter of 4.5 cm or more in an area of 50 x 50 m^2 (other unidentified species being 19), and the recent survey in Chruoy-smach showed 22 types of tree species having a diameter of 8 cm or more per 800 m^2 of forest indicating very diversification in the tree species in the forest of this region compared with those in the temperate or subarctic zone.

When compared to the example in the Malay Peninsula[7)] (58 - 59 tree species having a diameter of 4.5 cm or more per 40 x 40 m^2), the tree species in this region is far less diversified.

In the humid forest in this region, trees in the first story is the object of cutting. Among many species, the following Dipetrocarpus spp. are particularly important.

Chhoeuteal	Dipetrocarpus spp. (D. dyeri, D. alatus or D. costatus is the main species in the coast area).
Phdiek	Anisoptera glabra
Koki phnong (Komnchan)	Shorea hypochra (This species seems to be usually called as Koki in the coast area).
Koki Kusath	Hopea perrei

Other dominant species include.

Don chem	Terrietia cochinchinensis
Cham bak	Irvingia harmendii

The humid forest in this district comprises mostly the species of broadleaved evergreens but the species of first story, particularly Choeuteal sheds its leaves at the beginning of dry season, though only for a short period of time, and shows trees bare of leaves temporarily.

This seasonal rhythm of the first layer dominant is seen particularly in the humid forest in the region where dry season is more distinct. Therefore, the forest of

this type is also called "Evergreen seasonal forest"[4)6)]. The fact that this humid forest has fewer species having a huge buttress in its first story, which may be called as one of the characteristics of tropical rain forest, is also said to be related to the dryness of the weatehr in this region[4)].

The growth of humid forest depends greatly on the climate of the region and at the same time, has a close relation to soil conditions of the area. Soils in the humid forest area in this region are the reddish yellow latosol having a very deep layer of homogeneous fine sandy texture. Soils in the area where the growth of horest is not satisfactory are more sandy and less in thickness of the soil layer.

(B) Dwarf Forest

This type is an evergreen forest having a tree height of about 15 to 20 m, seen in the ridge of hills having a thin layer of soils or in the area between humid forest and swamp forest along the shallow valley.

The main species of high tree is common to that of the humid forest but specially characteristic is the frequent discovery of the following.

Romlieng (Rong Leang)	Tristania myrtasii

Also of special interest is the discovery of evergreen coniferous such as the following species.

Srol Kraham	Dacrydium pierreai
Srol sar	Podocarpus spp.

The forest of this type is also seen in other tropical zones where soils are sandy and drains well. The forest of this type is also called as "Heath forest". Compared with humid forest, the trees in this forest are low but high in density. Both tree species and the structure of story are also simplified. Though the forest of this type is not important economically this type has the largest distribution next to the humid forest in the coast area.

(C) Rear mangrove

The forest of this type is seen in the area in the rear of mangrove or the sands in the coast. (For this reason, it is called, "Rear mangrove"). In the area where the effect of the sea water is felt more or less a pure forest of Smach, Melaleuca leucadendron, is seen more frequently. This species is also called "Kayu putih" in Malay and widely distributed in the tropics. It is characteristics with Cambodia that this type of forest is seen not only in the marsh under the effect of sea water but also in the swamp along the valleys where the effect of sea water is not conceivable. The Kayu putih in these marshes generally grow in the land with a layer of cilica sand.

Results of a survey conducted by Kira[4], revealed that the impermeable pan below the silica sand layer is causing the dampness in the soil.

The forest is generally sparse and even the fully grown tree is about 10 m in height. The wood is used only for fuel and therefore the productivity of this type of forest is extremely low.

3-2 Natural Regeneration of Humid Forest

3-2-1 Actual State of Forest Regeneration

3-2-1-1 Present state of cutting and regeneration works

It is needless to say that of the forests in the lowland of the coast, the one which be the object of development is the humid forest. The following discussion will deal mainly with the regeneration of humid forest.

Incidentally, the recent survey was conducted mainly in SOKECIA's Chruoy-smach operation area and part of SOKECIA's Chekor operation area and SKEF's Kompong-som operation area because of limited time available.

Cutting by SOKECIA in recent years is directed mainly to the timber for export and the object of cutting is the timber having a diameter above 65 cm DBH (for export to Japan). Depending on the circumstances cutting of trees having 50 - 55 cm DBH or more (for export to Vietnam) is also allowed. The tree species that come under the category of cutting includes Chhoeuteal accounting for 40%, Phdiek for 20%, Koki-phnong (or Koki) for 20% and others (Koki Kusach, Donchem, etc.) for 20%. The method used is the so-called selection system and one out of the three trees or two out of the five of the cutting trees are preserved as mother trees. The mother tree to be preserved may also include trees having a diameter of about 40 - 50 cm DBH.

The above is the outline of the cutting operation now employed in the operation area. However, there have been almost no efforts made on the tending of stands after selective cutting. The state of forest regeneration under these conditions is quite pessimistic. We shall consider this problem in the following section.

3-2-1-2 Growth of succeeding trees after selective cutting

As the word "Selective cutting" means, next telling should be expected after a certain cycle of years. However, judging from the composition of forest where selective cutting has been made, succeeding trees of usable species are generally scarce. Particularly, the forest stand with appropriate diameter class distribution is few in number and as a result, the shortage of usable trees species with medium or small diameters is prominent.

Table 8 shows an example of the results of a survey made in Chruoy-smach operation area. These forest stands are regarded as excellent forest stands being graded as above the average of this operation district from the standpoint of distribution of usable tree species.

Table 8 Results of a survey on succeeding trees after cutting in SOKESIA operation district

Stand	(1)				(2)				(3)				(4)			
Month & year of cutting	April May 1968				February 1967				February 1967				November 1967			
Diameter class	L	M	S	Total	L	M	S	Total	L	M	S	Total	L	M	S	Total
Ch					1	5	4	10	1	2	1	4	1			1
Kp	1	4	1	6									1	2	2	5
Ph									1	1		2				
KK									1	4	6	11	1	1	6	8
Total	1	4	1	6	1	5	4	10	3	7	7	17	3	3	8	14
Others	2	7	15	24		5	11	16	2	8	12	22	4	7	25	36
Cutting				4				4				8				7

The number shown is for per ha, L:more than 50 cm.
M:30 - 50 cm, S:20 - 30 cm.
Ch:Chhoeuteal, Kp:Koki phnong, Ph:phdick, KK:Koki Kusach
The area covered by the survey is one ha.

In this operation area of SOKECIA approximately 1,500 ha is designated annually for cutting but the object of cutting is humid forest covering an area of about 1,000 ha after excluding poor humid forests and other types of forest of poor quality. From this forest approximately 4,000 timber are cut annually. At present the average number of felled timber per ha is only 4 (The average number is 2.7/ha for the whole cutting zone). The number of felled timber in each stand shown in Table 8 is either the average or higher than the average, indicating a high stock of commercial timber in these stands. In No. 3 and 4 where the stock of commercial tree is particularly high, the number of commercial trees reserved after selective cutting is also large but in No. 1 and 2 the number of regenerated trees can not be said to be adequate.

Still more, it is said to take quite a long time for the reserved trees to grow to the diameter class for commercial use even in the tropical forest. Data on the growth of tropical forest, particularly on the humid forest in Cambodia is very scarce or completely unavailable. The data by Rollet which was analyzed by

Nishizawa[8], during the last survey is considered as the sole information available. According to this analysis, the annual increment for the tree in the humid forest having a diameter of 50 cm is estimated at only 0.287 cm in DBH. This means that a tree having a diameter of 50 cm will take about 30 to 40 years to grow to a tree having a diameter of 60 cm.

Of course the situation may be different when the conditions surrounding the succeeding trees are specially improved for their growth but under the present system which provide selecting cutting of only commercial trees and almost neglect the care for other standing timber, much improvement of conditions can not be expected. Surveys on the quality of reserved trees which were left uncut in the natural forest because of insufficient diameter are mostly with a small grown compared with their height or are of crooked shape or have rotted portion or damages. It is not appropriate, therefore, to consider that all of the reserved commercial tree can be used in the future.

Assuming that the diameter class of commercial timber remains the same also in the future, at least 40 to 70 years must be expected before these standing timber can be cut. Even then, the volume of commercial trees will decrease to the level much lower than that of today.

Therefore, even with the selective cutting of such a low utilization rate but if the rotation is such a long period as stated above, the development of humid forest in the coast area will soon face a serious problem in the preservation of forest as far as Chhoeuteal, Phdick and Koki phnong are concerned.

3-2-1-3 Seedling and sapling of commercial species

Table 9 below shows examples of the survey on seedlings and saplings of commercial species (The stands are the same as for Table 8).

Table 9 Examples of survey on seedlings and saplings after cutting in SOKESIA operation district

Stand	(1)				(2)				(3)				(4)			
Classification	L	M	S	Total	L	M	S	Total	L	M	S	Total	L	M	S	Total
Ch	1	1		2	5	22	9	36		1		1		3		3
Kp	3	23	273	299						1		1	5	2	2	9
Ph					2	5		7		2		2	6	2		8
Total	4	24	273	301	7	27	9	43		4		4	11	7	2	20
	(100)	(600)	(6875)	(7575)	(175)	(675)	(225)	(1075)		(50)		(50)	(275)	(175)	(50)	(500)

(Notes) 1. Height of seedling: L:More than 2 m, M:0.5 - 2 m S:Less than 0.5 m.

2. The number of seedlings shown is for per 400 m^2. Figures in parentheses represent the number for per ha.

3. Stand No. is the same as in Table 8. Surveys were made on 20 plots of (2 x 10)m^2 for every ha of the stand.

The table shows various states of growth seedlings and saplings depending on the conditions of individual forest. In stands 1 and 2, number of seedlings and saplings is more frequent because of relative scarcity of upper story crown, less vegetations in the forest ground.

Particularly in No. 1, concentration of seedlings less than 50 cm in height, regenerated after selective cutting, was seen at the road-side provided for skidding and transportation of timber. However, the young trees having a height of more than 2 meters were not in large number.

According to the standard regeneration method[9], employed in Malaysia for the humid forest, a survey on the growth of seedling is to made by dividing the area into blocks, each having an area of about 25 m^2, and when satisfactory distribution of young trees (Mostly 1.5 - 3 m in height) is seen in 50% of the all sampled plots, regeneration in that forest stand is said to be a success.

The summarization of the results of the survey shown in the foregoing Table 9, that is the total of surveyed plots by the number of young trees regenerated in each plot (20 m^2) may be illustrated in the following Table 10.

Table 10 Distribution of young trees

Plot		(1)	(2)	(3)	(4)
Number of trees per plot*	0	10 plots	11 plots	18 plots	9 plots
	1~2	6	5	2	9
	3~4	2	1		2
	5~6	2	2		
	7~		1		
Total		20 plots	20 plots	20 plots	20 plots
Rate of regeneration**		50 %	45 %	10 %	55 %

Notes) * The number of young trees (more than 50 cm in height) regenerating in a 20 m^2 sample plot

** $\frac{\text{The number of plots in which young trees regenerated}}{\text{The total number of plots sampled}}$

In this survey the young trees less than 50 cm in height were not counted.

From Table 10 it is known, according to the Malaysia standard, that Stand 4 is the only plot where the frequency of plots having one or more young trees exceed 50%. Even with the young trees more than 50 cm in height it will probably the same. Moreover, this is the standard in Malaysia on the assumption that there must always be nursing afterward. Therefore, with the present state of regeneration and stability of young trees as shown by several examples, it is not appropriate to expect these young trees to regenerate the forest at the present rate when the effect of shade by upper story and the competition with weeds and capse, particularly the vines in the event of no nursing in the future.

The above examples show only part of the results of the survey. Also from the observation of each operation district it was felt that as long as the present operation method is used, regeneration of commercial trees by newly regenerated young trees was almost impossible with the exception of a few cases.

3-2-2 Natural Regeneration Method

3-2-2-1 Malayan uniform system

As discussed previously, regeneration of humid forest in the lowland of Cambodian coast involves many problems. With the present pace of development and cutting method, continued production of Chhoeuteal, Phdick and Koki phnong is considered very difficult.

In order to promote a steady regeneration and plan continued regeneration, it will be necessary to employ comprehensive silvicultural techniques.

Silvicultural surveys and researches made in various locations of tropical zone already showed that the regeneration of tropical rain forest was almost impossible by merely relying on the selective cutting of commercial trees.

For this reason, various regeneration techniques have been developed in many parts of the tropical zone to suit to local requirements[9)10)]. In Tropical Asia, particularly in India, Ceylon, Thailand and Malaysia, much efforts have been made for the study of regeneration method for tropical forest from old times and some methods have been put into actual use. In Malaysia, particularly, the regeneration method for tropical rain forest in lowland has been given a systematic structure and the so-called "Malayan Uniform System" has been established as a means of natural regeneration[11)12)].

The Malayan Uniform System has been developed after intensive studies on various regeneration methods of the past and is said to be the best among natural regeneration methods for tropical rain forest at present.

The outline of this system is given in the annex. With this system a survey is made of young trees and regenerated trees of commercial tree species in each forest stand prior to cutting and a judgement is made on the advisability of cutting of certain tree species and on cutting method. Furthermore, a survey is also made on the growth of young trees after cutting and nursing is provided at appropriate times to insure the growth of young trees. In short, it is a method which insures a rapid and accurate regeneration of commercial trees in the forest. When the young tree is considered inadequate in number or the growth is not satisfactory, this method always provides artificial planting called the "Enrichment planting".

Though all the natural regeneration methods presently employed in Malaysia are based on this system, there also are many cases in which modifications are made to the method depending on the conditions of the forest and management requirements and simple methods adaptable to actual conditions are being employed.[13)14)15)16)] Anyway, it is evident that substantial regeneration of humid forest in lowland of the tropical zone can not be accomplished without the implementation of considerably extensive tending work.

If the regeneration of humid forest in the lowland of the coast area is to aim at the production of commercial timber of large diameter class like today, it will be inevitable to introduce the Malayan Uniform System as a rule and make the most of the system by adapting it to the natural condition, actual state of forest management and the level of techniques.

The points which must be taken into consideration in the implementation of natural regeneration of humid forest in the low coast area with the objective of producing timber of large diameter will be as follows.

(1) Removal of trees which impede the regeneration of forest

In order to implement the regeneration of humid forest by introducing the Malayan Uniform System, it is necessary to remove uncommercial upper trees which might impede the regeneration of commercial trees and to remove densely grown vegetation in the middle and lower stories prior to the start of cutting of commercial trees. Implementation of this work, which requires a considerable amount of cost, may face some difficulties under present conditions of forestry in Cambodia. However, this work is indispensable for the continued management of humid forest in the lowland of the coast area, which is considered to be of poor quality from the standpoint of regeneration, as previously stated.

Since studies are being made on the advisability of developing tropical forests as a source of pulp wood and there is an increasing possibility for such development, it will be necessary to plan the removal of trees which impede the progress of the regeneration along with the utilization of these trees.

(2) Shortages of young trees and regenerated trees

Even when the removal of trees which impede the progress of regeneration is implemented prior to the start of regeneration work, there will still be a need to plan positive planting intended for regeneration by means of Enrichment planting for the majority of districts, though the degree of requirement may vary with each district. Details of Enrichment planting method will be discussed later.

If any means can be found to utilize large trees of the types other than those being utilized at present, the number of tree species which can be expected of regeneration will increase and the stability of regeneration work will also be increased.

(3) Establishment of Regeneration method

The present level of natural regeneration techniques in Cambodia is extremely low and there are very few personnel who have had any experience in this field. For immediate application of highly technical regeneration method such as the Malayan Uniform System, which has been established as a systematic method of forestry management, a shortage of technicians and skilled workers will be a major obstacle. It will be necessary, therefore, to plan the establishment of management system adoptable to local requirements while making efforts for the acquisition of natural regeneration techniques such as the Malayan Uniform System and implementing model regeneration projects to accumulate experience in this field.

3-2-2-2 Enrichment planting

As stated previously, one of the outstanding characteristics of the natural regeneration method employed in Malaysia is that the management system is so

arranged that intensive auxiliary regeneration work can be employed effectively according to the progress of regeneration work and at the same time, Enrichment planting of commercial tree species has been positively introduced for the forest stands where the regeneration work proved to be insufficient.

The outline of the Enrichment planting method employed in Malaysia is given in the annex. It has already been mentioned that the Enrichment planting method must be employed for the regeneration of humid forest in the lowland of Cambodia's coast area.

In such a case, however, the following points should be given special attention.

(1) Planting species

It is needless to say that the tree species selected for Enrichment planting should be of the type native to the humid forest and that further studies should be made to determine the species which is most suitable for the regeneration. Data on the humid forest in Cambodia is very scarce in this respect.

From the results of the recent survey, however, the following species are conceivable.

Koki phnong (Shorea hypochra): Though this species affords relatively favorable regeneration, it is not a fast growing species.

Chhoeuteal (Dipterocarpus dyeri and D. costatus or D. alatus): D. dyeri grows relatively fast in its early stage and is also suitable for regeneration with satisfactory result.

Phdiek (Anisoptera glabra): This species requires favorable light conditions during its young growth stage.

Dom chem (Tarrietia cochinchinensis): The growth of this species is quite satisfactory in its young stage and suitable for regeneration with satisfactory results in many cases.

As to the species which are highly probable for introduction from other countries, commercial trees found in the tropical humid forest on the coast of the Malay peninsula are conceivable and among them the Shorea (Red Meranti) which grows relatively fast is considered most promising. For Enrichment planting of coniferous trees, introduction of Agathis is conceivable as in the case of Malasia.

In any case, it will be necessary to plan early experiments on Enrichment planting for both the native species and introduced species to obtain data on their growth.

Even when the Enrichment planting is implemented with these species it will take a considerably long period of time for these trees to grow to the size

now required of the commercial trees judging from many examples in various parts of Southeast Asia. It will be from 60 to 100 years[13) 17)] before the trees in humid forest to grow to the required diameter class under favorable conditions. As previously mentioned, soil and climatic conditions in Cambodia are not so favorable compared with those in other countries where tropical rain forest are found. For this reason, the lapse of 100 year or more must be expected before the trees grow to the diameter class ready for cutting.

(2) Planting and tending

For Enrichment planting, both the row planting and the group planting methods are conceivable. Detailed planting techniques and the number of trees to be planted with these methods can not be set as a standard because these are closely related to the intensity of management growth of regenerated trees and the rotation age. However, judging from many examples in various countries and the existing conditions in Cambodia, it will not be practical to apply such an intensive method to this case. On the assumption that the number of trees to be cut is 40 - 60/ha, the number of trees to be planted for enrichment planting will be 200 - 300/ha. In the case of row planting, if the space between rows is to be 15m and that between seedlings is to be 3m, the number of trees required for enrichment planting will be 220/ha, which will be used as a standard for adjustment of the space between rows depending on the conditions of each forest. Each planting row must be completely free of vegetations for a width of 2 meters.

A survey of cutting areas including SOKESIA operating district shows a considerably large number of roads in the operation district, which were built for the purpose of transporting timber by trucks (In the case of SOKESIA, for example, the total length of roads for truck within the forest having an area of about 1,000 ha is about 30 km). Moreover, there is considerably a large number of vacant lots, which were formerly used as the passage for timber skidding or the cut-over area, along these truck roads. Rehabilitation of vegetations in these spaces is not progressed satisfactorily for several years after cutting operation. It was considered advantageous, therefore, to plan enrichment planting by means of row planting and group planting in these spaces (Not possible in the area where errosion of surface soil is seen, of course), when necessary, from the standpoint of cost and the future tending.

It is not too much to say that the success of Enrichment planting depends on the tending of trees before and after the planting.

Land preparation, removal and girdling of trees which might hamper the growth of regenerated trees in the enrichment planting area prior to the

planting must be implemented without fail. Use of herbecides in this purpose will also be considered in the future. When it becomes possible to utilize uncommercial trees of small and medium-diameter class for row wood as mentioned in the foregoing section, removal of trees which hamper the growth of commercial trees may be accomplished more easily. In that case production of pulp wood is conceivable along with enrichment planting of commercial trees. It will be advantageous to plan mixed row planting of species of short rotation for pulp wood such as Anthocephalus spp. and Sarcocephalus spp. or fast growing pines (Pinus merkusii or P. caribaea) between the rows of commercial trees, if possible.

Weeding after enrichment planting, particularly the removal of vines, is the key to nursing. Vines are relatively thin in the primeval forest but once the forest is thined out by cutting they will grow thick rapidly. During the survey it was observed that almost all the trees of large and medium diameter class which were preserved after cutting of commercial trees, had veins on them.

Nursing of seedlings prior to enrichment planting is an important factor but in Cambodia nursing techniques are still undeveloped as may be seen in the later discussion.

The country lacks experience specially in the nursing of species suitable for enrichment planting. It will be necessary, therefore, to plan the establishment of techniques by beginning with small nursery by referring to the techniques employed in Malaysia[10)11)13)18)19)].

Seeds of Depterocarpaceae in the tropical zone have a very short life and the yield of seeds varies greatly with the year and individual trees. It will be important, therefore, to make studies on varies questions such as flowering habits, harvesting and storage method of seeds, and seeding method as early as possible. It is natural that the enrichment planting requires more capital investment than with the simple natural regeneration method. The cost required greatly varies depending on actual conditions of forest stand. In the case of Malaysia[11)13)], for example, the cost required for the forest having 400 - 500 planted trees per ha during a period of 10 years after planting is estimated at 50 - 75 man/day per ha or $70 - 100/ha. In Cambodia, therefore, the standard cost will be around US$80/ha.

For details of Enrichment planting, refer to bibliographies quoted.

3-2-2-3 Regeneration by means of block clear cutting and strip clear cutting

As stated previously, the regeneration method that can be considered for the production of timber of large-diameter class at first is the Malayan Uniform System (including Enrichment planting). Judging from the present conditions of forest industry in Cambodia, however, planning of the production of timber of

large size in the humid forest in the entire coast area with this system will face many difficulties both technically and economically. For this reason, intensive production of timber of large diameter will be limited, to some extent, to the area where regeneration may be implemented with less difficulty and where productivity of the forest is relatively high.

Therefore, except the forest in which positive production of large timber is being carried out, the tempo of regeneration will be slow and the forest type will be further deteriorated. It will be inevitable, however, to plan the development of these areas with the existing selecting cutting method.

In such area as Kompong-som where regional development is fairly advanced, however, production of raw wood including pulp wood is also planned along with the timber production of larger size.

If this type of development is to be employed in the future, reutilization of the forest which showed poor results of regeneration in the past may be possible. In such a case division of forests for teh production of raw wood and the regeneration method for the forests after the production of raw wood will be the main question. As stated previously, elimination of unqualified timber of small and medium size is necessary for the implementation of natural regeneration and utilization of such unqualified wood for raw wood may be an indication of advantageous aspect of the regeneration of tropical forests. However, since it will be desirable from an economical point of view to provide intensive cutting and utilization of timber in the production of raw wood, it will be unavoidable to see an increase in the number of forests which will be given a clear cutting in this respect.

It is evident from many examples of various countries that the clear cutting of humid forests in large area may result in the run-down of soils and erosion of ground, thus degrading the fertility of soil and deterioration of forest productivity. Particular under present conditions when silvicultural techniques have yet to be established in the tropical zone, clear cutting of forests in large area must be avoided even when the effect on the fertility of soils is not too great.

It is very probable, therefore, to adopt block clear cutting method and strip clear cutting method in part. There is notdoubt that the artificial silviculture method is most reliable and stable as a regeneration method for cut-over areas. However, under present conditions in Cambodia which will be discussed in detail later, the artificial plantation just got under way and consideration will also be given to the adoption of natural regeneration methods along with the former.

It is evident from various studies made in the temperate regions and the sub-frigid zone that the success of natural regeneration of forest following block clear cutting and strip clear cutting depends largely on the configuration and the size of cleared area of the forest as well as natural conditions, but there are

extremely few cases of research and study made in this field of the tropical zone. It may be safely said that there have not been any studies made in Cambodia in this respect. During the current survey the team observed only a portion of cut-over area which was intended for the development of farm land.

It was presumed that in the case of a small area the forest stand was formed with intolerant species and the native species among the regenerated primeval forest in relatively a short period of time. The condition of recovery in large cut-over area, which had been left unattended, however, was very pessimistic and the area presented an appearance of a jungle of vines, invaded intolerant species and regenerated trees by shoot, which made it very difficult to forecast the future conditions of the forest.

In planning the regeneration by means of complete clear cutting, it will be necessary to make a full study on the configuration and the size of cutting area plus the possibility of regeneration and the maintenance of the fertility of soils. For that purpose, establishment of test areas will also be necessary.

3-2-2-4 Classification of forest consistent with natural conditions and management requirements

From the past discussion it is evident that the indiscriminate application of the present selection cutting method to the future regeneration of humid forest in the low land of Cambodian coast will present many problems. In order to maintain the existing production level of commercial timber with the consideration of the difficulty of regeneration, land productivity and further the economical problems in relation to the development of coast area, it will be necessary to reclassify the forest into the following categories. The forest which will be provided with the aforementioned natural regeneration intensively, the forest which will confine its regeneration by means of the present crude selective cutting method, the forest which will be expected to produce raw wood such as pulp wood and the forest which will introduce artificial silviculture methods. Only this way it will be possible to plan reasonable application of techniques consistent with natural conditions and the management requirements of individual forest.

The humid forests on the hill of the coast area are not necessarily identical in every respect and considerable muldistribution of commercial tree species and greater variations in the environments for the growth were also observed. Even in respect of regeneration alone, it was felt that there was considerably a wide difference in the difficulty.

More effective classification of forests can be accomplished if more detailed studies are made on the existing structure of forest stand and land conditions from a standpoint of regeneration and growth of trees by adopting a combined survey method of aerial photogrammertry and land surveying, by stepping foreward from

the present method of surveying natural resources. For this purpose, it will be necessary to implement a survey aimed at establishing a classification method of forest type by selecting a forest area as a model.

3-3 Afforestation

3-3-1 Afforestation in Tropical Zone

3-3-1-1 History of afforestation in the tropical zone

According to Wadsworth of the United States, South Asia was the first among the three tropical zones to afforest. In later years it spread to Africa and in much later years it advanced to American continent.

Teak was planted in India for the first time in 1830 for trial and the famous teak plantation in Nilambur, Madras Province was established in 1844. Though the start of afforestation in Java is unknown, there is a view that the planting of teak began in quite early days. According to this view (Becking 1951) teak was not native to Java but was brought in from the continent about 350 years before and grew in the form of a natural forest. However, the basis of the present planting techniques of teak is said to have been developed in 1880. Afforestation made its debut in Burma in 1840, Ceylon in 1890, and after the turn of this centry it was introduced to Thailand, the Philippines and further to tropical Australia and Trinida. In the 1920's afforestation was attempted in the British, French and Belgian colonies in Africa. Trial planting of teak in Cambodia seems to have been made around this decade.

At present almost all the countries in the tropical zone has plantation to some extent and the total area of plantation in the world, according to Wadsworth, is estimated at one million acres. The tree species planted in South Asia numbers 1,000 and that in Africa totals 500.

However, the species which planted widely throughout countries in tropical zone is very limited in number and only such species as Acacia, Agathis, Albizzia, Casuarina, Cedrela, Cupressus, Eucalyptus, Pinus, Swietenia, Tectona, Terminalia can be mentioned.

3-3-1-2 Outline of afforestation in Cambodia

In Cambodia the plantation covered an area of 5,359 ha as of 1965 and additional 836 ha was created by 1968. In recent years the annual afforestation area is in the range from 200 to 300 ha. Teak accounts for the largest share in the plantation and the total teak plantation area is 2,014 ha. Teak plantation of small scale is scattered. Besides, plantation of such broad-leaved species as Koki (Hopea Odrata), Chhoeuteal (Dipterocarpus spp.), Trasek (Peltoforum sp.) and Angkanh (Cassia siamea) is provided in areas totaling 3,606 ha and forests of small scale spread all over the country.

During a period from 1965 to 1967 plantation of Pinus merkusii located in O-Raing, Mondulkiri province, 900 meters above sea-level, expanded to 239 ha. The forestry authorities of the Cambodian Government consider the species suitable for planting in the order of teak, Koki, chhoenteal, pinus merkusii and trasek, and give top priority to the teak.

3-3-2 Afforestation in the Coast Area

As mentioned previously, afforestation in Cambodia has a short history and has shown little achievements. Plantations of small scale scatter all over the country depending on the adoptability of the species to local conditions but no achievements of afforestation have been recorded for the coast area of Cardamome where regional development was far behind. However, as stated in Chapter II, 2-4-2 of this report, there is a possibility for the introduction of enrichment planting or artificial regeneration into this district in the near future.

To prepare for the full-scale artificial regeneration, it will be necessary to conduct a trial planting on a small scale.

3-3-2-1 *Selection of species for trial planting*

In selecting species for trial planting at least two factor should be taken into consideration. One is to select the species which is considered appropriate for the climate and soil conditions of the proposed area from a standpoint of botanical ecology and the other is to select the species which has a potentiality of producing profit from the standpoint of forestry management. Composition of vegetations in the tropical zone varies greatly depending on the annual rainfall, particularly the annual rainfall distribution and the length of the dry season. The composition is also influenced by forest soils, particularly the moisture content of the soil.

According to F.A.O. "Choice of Tree Species" (1958) the evergreen rain forest exist in the low land of tropical zone, where dry season does not exceed two months (only the months in which monthly rainfall does not exceed 50 mm) or the annual rainfallis generally over 1,900 mm and may be very much more. It is well distributed throughout the year so that there is no dry season, or only a very short one. The mean annual temperature is about 27°C with very slight monthly change and rarely falls as low as 21°C. As the samples of the more important tree species appropriate for the regions under there weatehr conditions, the following species have been mentioned.

Agathis borneensis, Balanocarpus heimii, Casuarina equisetifolia, Eucalyptus deglupta, Gonystylus bancanus, Hopea odorata, Mesua ferrea (all of the above mentioned species are asian origin). Besides five african species and five american species have been mentioned.

Dry season of two to four months. · The annual rainfall may be as high

as it is in one just described, that is to say 5,000 mm or more, and may be as low as 1,600 mm where the dry season is short. The mean annual temperature is still about 27°C but there is greater seasonal variation, and the mean temperature of the coldest month may be about 18°C, with correspondingly higher temperatures in hot season.

Species mentioned as important species having adoptability to the above weather conditions are given below.

Albizzia lebbek, Artocarpus integrifolia, Cedrela toona, Diptirocarpus alatus, D. turbinatus, Gmelina arborea, Lagerstroemia flosreginae, Pinus merkusii (The above-mentioned species are asian origins).

Besides, eight African species including Khaya ivorensis and such American species as Swietenia macrophylla, Pinus hondurensis, Ochroma lagopus and three other American species have also been mentioned.

The above mentioned species are the examples of more important species and besides these species such Asian species as Agathis loranthifolia, Albizzia falcata, Anthocephalus cadamba, all of which are in wide use for afforestation in Indonesia and the lumber of which are seen on the market, are considered suitable to the above given two weather conditions.

As previously stated in Section 1 of this Chapter, which dealt with the weather and soil conditions in the coast area of Cardamome, the annual mean temperature in Kompong som is 27.8°C and the annual rainfall is 3,726 mm with a three month dry season (Only the months in which monthly rainfall does not exceed 50 mm). The soils are composed mainly of sand, the origin of which is sandstone and the fertility is very poor.

In selecting test species for this region it will be sufficient to choose the species which will be suitable to the above two weather conditions, from a logical viewpoint.

In selecting test species from the standpoint of forestry management the following points may be used as a parameter.

(1) Species which grows fast and has a short rotation having a value in lumber.

(2) Species which grow fast but especially increase their value in relatively a long period of time in large diameter.
These species are highly valued and their prices are correspondingly high.

(3) Species which have already been tried for planting and the lumber is in the market for actual transaction.

Selection of species from the above standpoint (including some of which may deviate from this concept to some extent) will lead to the following.

3-3-2-2 Species for trial planting

Pinus spp.

(1) P. merkusii

This species is seen in natural distribution in Burma, Thailand, Cambodia, Vietnam, Laos, the Philippines and Indonesia (Northern part of Sumatra) where one has to distinguish between several races, the ecological requirement of which differ. In Thailand this species grows wild in the area having elevation of 150 - 500 m and is highly resistive against dry weather and poor fertility of soils but its growth is not satisfactory. In Cambodia and former Indochina territories this species grows wild in the high land (elevation being 500 to 1,000 m) and shows favorable growth under humid weather conditions with an annual rainfall of 1,500 mm or more and in well drained land. The species growing wild in the low land of these regions has considerably a high resistivity against clayey soils but is more adoptable to humid weather having an annual rainfall of 1,200 mm or more and its growth rate is moderate.

This species in Indonesia is also called as "Sumatra pine" and has a wide range of adaptability from the low land to the high land 2,000 above sea-level with an annual rainfall of 3,000 - 4,000 mm to the minimum of 500 mm. However, it would grow best in the land having an altitude of 500 - 2,000 m and in humid area with an annual rainfall of 1,500 mm or more. The growth rate of this local species is exceptionally high and is the best among the local species seen in other regions. It requires well drained soil, however. Pinus merkusii in the Philippines, resembles to the one in Indonesia ecologically but the former is slower in growth.

In Malaysia trial planting and afforestation of pine in lowland were begun several years ago. Judging from the result of experiments conducted in Malaysia during a short period of time the pinus merkusii which grows in highland of Thailand and Indochina seems to have low growth rate and does not appear very promising. On the pinus merkusii in Indonesia, it has been reported that this is a growth potentiality equal to that of Honduras pine (discussed later) and this species is said to be very promising at this stage. However, the trees are still young and it will be sometime before full evaluation of this species can be made.

Planting of pinus merkusii in Indonesia dates back to around 1930 and the total area of afforestation is 130,000 ha at present. Planting is made mainly in the glasslands or abandoned farm lands having low fertility. The project has already entered in the stage of production and part of the lumber is consumed domestically as pulp wood or raw wood for the manufacture of matches and part are being exported to Japan as logs. The annual production including part of natural lumber is about 150,000 m^3.

As already mentioned in Chapter II, 2-2, planting of pine in Indonesia is provided mainly in the highland because of the requirements of land use. For growth rate of pine in Indonesia, attached "Growth and Yield Table" (Annex 4-2) gives detailed information. At average site class and the rotation of 30 years, the number of stems per ha is 154, average height is 35.5 m, average diameter is 48.7 cm, volume of main stand per ha is 322 m^3 and the mean annual increment per ha is 21.4 m^3. Our survey in the area of Siantar District Forest Office revealed that the majority of pine plantation were showing the growth rate equivalent to that under site class III which is lower than the aforementioned site class IV.

Details of nursing for seedlings, planting method and silviculture accounting are given in annex.

(2) P. caribaea var. hondurensis (P. hondurensis)

This pine is the only species growing wild in the lowland of the tropical zone with the exception of the previously mentioned P. merkusii. This species grows wild in the form of open forest in the coast area (Elevation from 0 to 120 m) of British colony Honduras, Guatemala and Cuba and grows in dense forests. This species also grows wild in mountain areas having an altitude of 450 m to 900 m. The soils in the lowland of the coast in these countries comprise white or greyish sands and accompany an impermeable clay layer 60 to 120 cm below the soil surface. The annual rainfall is from 1,250 to 2,000 mm and the dry season lasts for 3 to 4 months.

Consequently, soils in the lowland have excessive moisture content during the wet season and soils become extremely dry during the dry season. In the sloped land where drainage is satisfactory pines grow much faster than in the lowland. This species grows fast in general and produces strong durable lumber.

In Malaysia studies have been made since 1956 on the adaptability of this species to the afforestation for lowland and trial planting has since been conducted. As a results, it was found that this species required less complexity in nursing, was suitable to planting in Imperata cylindrica glassland, fast in growing, and less susceptible to serious blight. Therefore, it is regarded as the species adaptable to planting in lowland having a possibility of large scale afforestation.

Full-fledged planting began in 1966 and so far about 900 acres of plantation has been created centering on Selangor province.

As to the growth of planted trees, it is not possible to make a long range forecast because of insufficient data available. Available data predict, however, that even in the land where fertility of soils is extremely poor, increment of 14 m^3 (per ha) can be expected if soils have a considerably thick layer. However, the planting of Pinus (including Pinus merkusii) in

lowland should be aimed at fast growing and short rotation. For this reason, it will be rather difficult to hope for the production of lumber of large diameter class, which require a long period of time. As to the prospect of demand for the lumber to be produced in these plantation, it will be appropriate to consider the future demand as equivalent to that for the previously mentioned pinus merkusii even though no actual marketing of this species has yet been made in Malaya.

In Malaysia there are two main problems in relation to planting of this species. One is the appearance of trees called "fox tail" which have no branches in the plantation (cause of which is still unknown) and the other is the fact that non of the planted trees has fructified yet.

Agathis spp.

(3) A. loranthifolia

This species grows wild in the land 200 to 1,500 in elevation in Molucca Island, Indonesia and grows to a height of 60 m and to 200 cm in diameter. This species shows favorable growth under humid weather with an annual rainfall of 3,000 to 4,000 mm and balanced distribution of rainfall throughout the year. Soils most suitable to the growth of this species are deep layer of porous soils with high fertility in the sloped land where drainage is satisfactory.

Conditions of the land in the coast district of Cardamome, particularly the soil condition is not considered capable to raise this species. However, in consideration of the possible selection of land with specially favorable soil conditions, this species has been selected for the inclusion in the test species.

In Java seeds were first brought from Ambon about a centry ago and the planting was made as wayside trees at first. Because of exceptionally favorable growth of this species, however, afforestation of this species began in 1917. The old plantations have already turned out lumber for marketing and the lumber 50 cm or more in diameter is used for venear and the rest is used for general lumbering. Under the Forest Industry Plan now in effect in Indonesia, Agathis lumber less than 30 cm in diameter must be used as pulp wood. Under the plan it is scheduled to implement mass production of Agathis and Pinus merkusii and to construct a paper mill in the neighboring area.

At present the total plantation area is 22,000 ha (in 1969) but the planting program is being implemented steadily with the aim of expanding the total area 141,000 ha. Planting is being carried out mainly in the highland 600 m or more above sea-level because of the requirements under present conditions of land use.

Table 11 Climate in Agathis loranthifolia plantation area
Baturanden, Java, Indonesia (Elevation - 610 m)

1. Temperature °C (1960 ~ 1963)

Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Average Maximum	24.8	24.4	25.1	24.7	24.7	24.5	23.4	22.6	23.6	24.9	24.6	24.9
Average	24.6	23.9	22.5	22.7	22.7	22.0	20.9	20.6	21.3	22.3	22.5	22.4
Average Minimum	20.2	20.1	20.1	20.7	20.6	19.6	18.2	17.6	18.1	18.8	20.0	19.5

Note: The maximum temperature to which the growth of Agathis loranthifolia has the resistivity is 30°C and the minimum temperature required for its growth is 11°C.

2. Humidity (%) and rainfall (mm) (1960 ~ 1963)

Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Hunidity	94.7	93.3	93.8	94.1	92.5	90.7	92.8	9.2	91.9	92.4	94.4	95.1
Rainfall	815.1	588.0	666.3	663.3	450.0	288.5	181.0	152.3	147.0	624.0	312.5	777.5

The yield table prepared by the Forest Research Institute is given in Annex 5-2. This table shows that at average site class (III) the rotation of 50 years, the number of stem per ha is 211, average height is 40.3 m, average diameter is 57.1 cm, the volume of thick wood of main stand per ha is 750 m^3 and the mean annual increment per ha is 24.9 m^3.

The most serious problem that confronts the afforestation of A. loranthifolia in Indonesia seems to be the supply of seeds. A ripe cone contains from 10 to 25 (sometimes 50) viable seeds on a total of 30 - 60 seeds per cone.

The germinative capacity of seed falls off rapidly and air dryed seeds lose their germinative capacity very quickly. After 14 days the germinative capacity is reduced to 40 - 50% and after 6 weeks the seeds do not germinate at all. But when they are packed in charcoal powder moistured with a 1% Nacle solution, the germinative capacity is maintained at a level of 50% after four weeks storing. As a result, supply of seeds to wider areas is substantially obstructed and this fact is a major obstacle to the expansion of Agathis plantation.

Details of nursing of seedlings, planting method and silviculture accounting employed in Indonesia are given in the Annex.

For Agathis, classification of species has not yet been established. There are some botanists who consider that A beccarii, A loranthifolia, A bornesensia, A. alba are all the local species of A alba and a report in Indonesia describes A. loranthifolia as A alba. In view of the fact that in Malaya native A alba is considered as the main species for enrichment planting for lowland, it will be important to make a careful study on the country of origin prior to the procurement of seeds for trial planting.

(4) Agathis borneensis

This species grows in the tropical humid forest in the area ranging from lowland to highland up to 600 m in elevation in Borneo and grows to a maximum height of 50 m and to a diameter of 60 cm. This species grows in the area of sandy soils with rather a poor water holding capacity and in groups in place of dipterocarp forest.

This species is considered to have adaptability to the environments in the coast area of Cardamome.

The problems are that because almost no attempts have been made for trial planting to say nothing of afforestation, there is no data available as to the growth of this species and that the germinative capacity of seeds falls off rapidly, and therefore the difficulty in procuring seeds must be expected.

(5) Albizzia falcata

This species is one of the main species now used in Indonesia for afforestation along with Pinus merkusii and Agathis loranthifolia under the Forest Industry Plan. This species is called as "Djeundjing" or "Sengon laut" in Indonesia and attention is being directed to it as one of the fast growing species. This species is native to North Molucca and is widely planted in Java and Kalimantan. It also grows wild in the land with the elevation of 0 - 1,500 m.

This species does not require fertile soil and shows favorable growth in both dry and humid soils and even in the land having a slight salt content.

Its growth is exceptionally remarkable, particularly in early age. The yield table prepared by the Forest Research Institute shown in Annex 6 shows that, until 5 years old at average site class (III), the average annual increment in height is about 4m, and quickly diminishing in older age, at the age of 8 - 9 years is about 1 - 1.5 m, and at 10 years of age it is only about 1 m. At 10 years old Albizzia falcata has been considered mature enough for the axe, producing on average site 194 m^3 per ha. The lumber has a specific gravity of 0.3 - 0.4 and is used for the manufacture of boxes, veneer and for light construction material.

In West Java the trees of this species are seen in the garden of farm house, along the river or around rice paddy in group or in row, and it has a part to play in satisfying demand for lumber in the region. Because of its rapid growth and light weight of lumber affording easiness in handling, this species is planted by many farmers partly for providing a windbreak but mainly for economical reason.

Besides Indonesia, this species is also given attention in the Philippines as a fast growing species and plantation of this species is being created as a source of pulp wood and veneer material.

Plantation of this species is seen more in the area where few dipterocarp trees grow wild and in the land overgrown with weeds.

(6) Anthocephalus cadamba

Like Albizzia falcata which has been mentioned previously, this species is a fast growing species and has been selected as one of the species for afforestation under the Forest Industry Plan in Indonesia. The main object of afforestation is to produce raw wood for the manufacture of match splints. This species is also called as "Kadan" in India, "Kelempayan or Jabon" in Indonesia and Malaysia and "Kaatoan Bangka" in the Philippines.

This species grows wild in the land up to 900 m above sea-level in the tropical zone extending from India to New Guinea and has wide distribution. Generally speaking, it is suitable to the soils that drains well and shows favorable growth when the rainfall ranges from 1,500 mm to 5,000 mm both in dry climate or in the rainy humid climate. The stem straight up to the top and has its lower branches at considerably high point. It is a typical light demanding species and has emerged as a pioneer plant of the secondary forest and has a strong resistivity against weeds and grows rapidly. This species is often seen on both sides of forest road in the site where lagging operation, transportation by tractor and shifting cultivation were carried. Indonesia has considerable achievements in plantation, on the basis of which an yield table has been prepared (See Annex 7). According to the table, the growth of this species in its early age is remarkable and the annual increment in height in the first five years is 1.7 m and the growth decreases gradually to 0.2 m in the 25th year. The table shows that at an average site class and the rotation of 12 years the number of stem per ha is 195, the average height is 21.2m, the average diameter is 27.1 m, the volume of main stand per ha as 113.5 m^3 and the mean annual increment per ha is 15.5 m^3.

Though there are some reports on the course of its growth in India and the Philippines, they deal with a tree (not stand) or give fragmentary information. As far as these reports are concerned, however, the growth of this species seems to be far better than that is shown in Indonesia's yield table.

Kelampayan lumber has a considerably wide range of specific gravity, being from 0.3 to 0.45. It is not clear whether this large variation is due to the indistinct classification of species or local conditions. In India the timber is used for the manufacture of tea boxes and board for building construction and also for building canoes. It seems that the timber is aimed mainly for the manufacture of match splints in Indonesia and for pulp wood and raw wood for veneer in the Philippines.

It seems that in the Philippines afforestation has not made much progress compared with Indonesia but as in the case of the aforementioned Albizzia falcata, the plantation of this species is also seen in the land where few dipterocarp trees grow wild and in the lands overgrown with weeds. From the past experience it is known that this species has a greater resistivity against wind than Albizzia falcata and therefore it is regarded as a favorable species for afforestation.

Local species of this Anthocepalus is frequently seen in the cut-over area or along the forest road in the coast area of Cardamome. However, there is no data available on its growth and the quality of lumber.

As it is considered possible to utilize the timber of this species for pulp wood with the present pulp manufacturing technologies, it is recommended to select this species for trial planting.

(7) Swietenia macrophylla

This species has long been used for afforestation in Indonesia.

It is native to Central and South America and its distribution is seen in the area extending from lat. 30°N in Eastern Mexico to lat. 18°S in Western Brazil. In Central America this species grows wild in the land up to 450 m in elevation and with an annual rainfall of 1,500 - 5,000 mm. In Western Guatemala this species is seen most commonly in the land within 15 km from the Pacific coast, where annual rainfall is 1,500 - 2,000 mm and where there is a five month long dry season. The growth in the land of less rainfall, however, is much poorer than in the wet land. It grows in the land of various types having a thin soil layer, humid soils or thick alluvial deposit but it seems that this species is most suitable to the sloped land where soils drain well.

According to the yield table prepared in Indonesia on the basis of many plantations of this species (see Annex 8), the growth of this species is satisfactory. According to the table it attains a height of 5 to 6 m in the first three years and at average site class the mean annual increment per ha is 15 - 20 m^3 with the rotation of 50 to 60 years.

The lumber is used for the manufacture of furnitures and cabinetwork along with Swietenia mahogany. It is the so-called precious lumber and is correspondingly highly priced.

(8) Eucalyptus spp.

Eucalyptus spp. is a fast growing species with high adaptability to the local condition. It is widely used for planting in warm regions throughout the world.

In tropic Asia introduction of this species began in the 1800's. However, the success of plantation was seen only in highland 1,000 - 2,000 m in elevation and almost all the attempts in the lowland have ended in a failure.

Successful species are:

E. Citriodra, E. globulus, E. mycrocorys, E. pilularis, E. camaldurensis, E. robusta, E. saligna, E. tereticornis.

Trial planting in the lowland of many species including E. citriodra (15° - 25°N), E. camaldrensis (15° - 38°N), E. robusta (23° - 36°N) and teretricornis (15° - 38°N), all of which are distributed in their native land in the tropical zone, has also been a failure. Only Troup said that E. teretricornis was promising but there has not been any clear-cut explanation as to his assertion Also the report on the small scale trial planting in Indonesia merely mentioned its evaluation by saying that teretricornis had better growth rate than camaldulensis.

According to F.A.O. "Choice of tree species", E. deglupta has been mentioned as a suitable species for planting in lowland of the tropical zone. This species is native to New Britain, Celebes and the Philippines and grows in the form of pure E. deglupla forest on river banks where soils are composed of alluvial sandy loam. The E. deglupta stand in these regions sometimes shows the volume of lumber as high as 900 m^3 per ha. It is also said that this species grows very rapidly and is worthtrial planting in lowland of the tropical zone. It is also reported that in New Britain this species often grows to 200 feet in height and 18 to 20 feet in girth and that planting is being carried out on a small scale in this region, but detailed information is not available.

It is very doubtful, however, if this species will grow satisfactory in the coast area of Cardamome where soil conditions are extremely poor.

(9) Others

The above discussion has dealt with tree species, mainly the foreign species, to be used for trial planting in the coast area of Cardomome. It is clear from the discussions of the past, however, that there are not many promising species which are suitable to the environments of the project area.
It will be necessary therefore, to consider the selection of fast growing native species among commercial tree species at the same time. In this sense, it may be advisable to make some trial planting of Casuarina equisetifolia and make studies on the course of its growth. For other native species, refer to 3-2-2-2, enrichment planting.

3-4 Regeneration of Kirirom Pine Forest

3-4-1 Outline of Pine Forest

Pinus merkusii (or Kirirom pine) is widely distributed in the tableland of Kirirom and adjoining northwestern plateau in Konpong speu province, creating pure forests and contributing greatly to the forestry in Cambodia as valuable coniferous forest resources.

As previously mentioned, the pine forest in the tableland of Kirirom covers an area of about 13,000 ha in the flat and gently sloped land 600 m or more in elevation. The annual mean temperature in the tableland of Kirirom is about 24°C. In Kompong speu in the east at the foot of the plateau (See Fig. 9) the annual rainfall is 1,200 mm[2]. It is presumed that the tableland has more rainfall than in Kompong speu but the rainfall is still considered to be fairly less than in the humid forest area.

The natural vegetation at the foot of the plateau comes under the category of the so-called semi-humid forest but there are quite a large number of forests which show an appearance of dry forest in the southeastern part of the plateau partly influenced by human work. In the steep slope of the plateau there may be seen some dwarf type forest and in the slope of open ravines in the plateau, where water content is more favorable in part, some broad-leaved forests including many evergreens are also seen. In general, however, the forest type in the area may be called as the semi-humid forest.

The pine forest showing a pure stand has a structure comprising uniformed age group for each section indicating that there has been a complete regeneration work naturally. The forest floor is dominated mainly by Inperata cylindrica (Grasses).

In sparse pine forests the growth of Thubeng (Dipterocarupus obtusifolius) mixed with other vegeration is also seen. Along the vally broad-leaved trees are dominant and pine trees are seen only sporadically.

Soils in the pine pure stand comprise a thick layer of reddish yellow sandy soil with sandstone for parent material but the surface layer of soil is either extremely thin or completely lacking. In the forest ground where there is an opening in the crown of the upper story of naturally regenerated pines, seedlings and saplings are growing in groups and there are many open lots along the road where the regeneration of seedlings is very favorable.

Judging from the appearance of the pine forest it seems that the Kirirom pine forest has come into being in the area which had been strongly influenced by human work such as shifting cultivation.

3-4-2 Regeneration of Pine Forest

Judging from natural conditions surrounding Kirirom pine forest, its regeneration may be easily accomplished. In actuality, moreover, natural regeneration has been

accomplished to some extent despite planless handling of the forest.

At present regeneration of Kirirom pine forest depends solely on the natural regeneration centering on the selective cutting of trees of large diameter class except for the area where the forest is maintained as an ornamental plantation. Such auxiliary works as the soil raking and clearing of under growth, which promotes regeneration of the forest, are not being performed except special cases. (for experiment only).

It is needless to say that in planning regeneration of a forest consideration must be given to the following factors.

(1) To plan the land conservation and take necessary steps to the preservation of fertility

(2) To ensure regeneration of cut-over land

(3) To make efforts to curtail regeneration period as much as possible

(4) To work out a regeneration plan which may be employed at the project area

(5) To develop reasonable, efficient and economical method for both cutting operation and transport operation

It may be said that the present system in handling Kirirom pine forest satisfies the requirements under the line (1), (4) and (5) but fails to satisfy the requirements under the line of (2) and (3). And because of poor results of the past regeneration under selection system, there are quite a large number of sparse forests. Artificial regeneration by planting may satisfy the requirements under the line of (2) and (3) but may confront many difficulties in satisfying the requirements under the line of (1), (4) and (5) in view of the natural conditions in Kirirom and the present state of forestry in Cambodia. For the regeneration of Kirirom pine forest, therefore, it will be more realistic to implement systematic natural regeneration in more intensified form of the existing planless regeneration method. In otherswords, in order to realize regeneration to the letter and in the shortest period as possible, it will be necessary to determine regeneration method by giving full consideration to the following natural and economical requirements.

(a) To make practical application of natural regeneration to the extent possible

In Kirirom location conditions such as soils, climate, and vegetation are favorable and suitable for natural regeneration. Even today there are considerably many places where regeneration of seeldings and saplings is favorably progressing.

Effots should be made to make the most of these seedlings and saplings to the extent possible.

(b) To provide effective and appropriate preparatory work for securing natural regeneration

In Kirirom there is quite a sharp distinction between the dry season and wet season and the falling of pine seeds is seen around May when the season changes from one to another. It will be necessary, therefore, to plan preparatory works such as soil

raking and cleaning corresponding to this timing.

(c) To plan appropriate combination of forest management operations such as cutting, timber skidding and regeneration

It will be necessary to plan combination of these works so that the efficiency of each work may be increased.

(d) To utilize machinery to the best advantage

The plateau of Kirirom is vast but has a relatively simple flat topography. It is possible, therefore, to make extensive use of machinery for such works as cutting, timber skidding, regeneration and tending. Since the human power is not inefficient in the tropical zone, consideration should be given to the introduction of machinery to the extent possible.

(e) To develop operation methods suitable to the existing condition of Kirirom pine forest

In Kirorom pine forest, the regeneration by natural seeding under seed-trees system can be expected. Moreover, reservation of mother trees is considered rather advisable when soil conditions and the existence of dry season are taken into consideration.

3-4-3 Regeneration Under Seed-Tree System

As stated previously, it is considered advisable to implement the regeneration of Kirirom pine forest centering on seed-tree system incorporating the pretreatment of site.

Detailed work method conceivable may be as follows:

A: Manipulation of under-growth and soil → cutting →
(clearing and soil raking by tractor) (reservation of seed-trees)
natural seeding → tending
(vine clearing, weeding removal of unwanted trees)

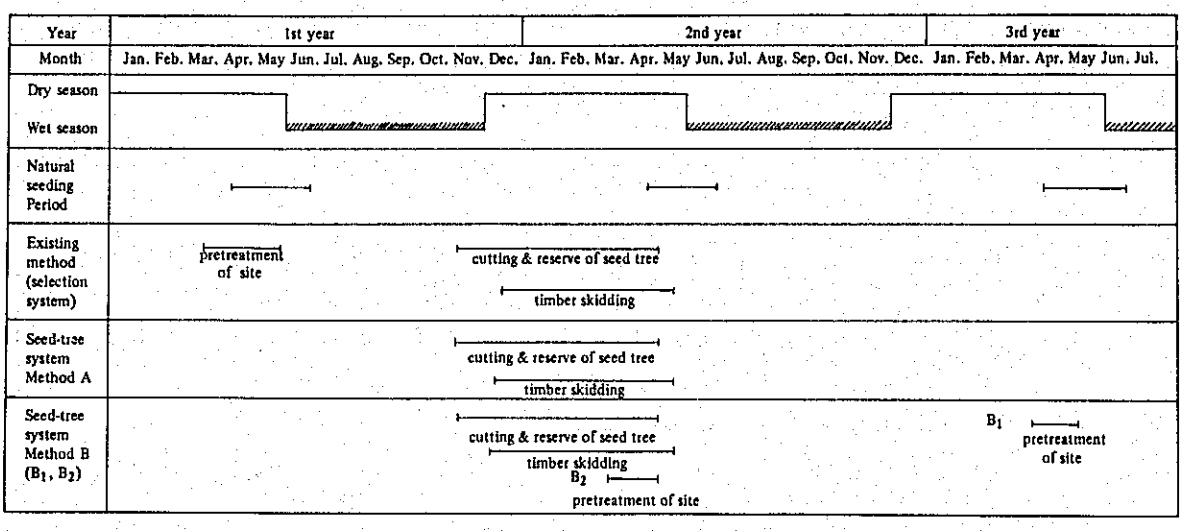
B: Cutting → manipulation of under-growth and soil →
(reservation of seed-trees) (clearing and soil raking by tractors)
natural seeding → tending
(vine clearing, weeding, removal of unwanted trees)

The only difference between the method A and method B is whether the manipulation of under-growth and soil is done before or after the cutting. Selection of the method is first determined by the cutting period. For example, if the contract calls for the cutting of the said forest stand later than June when the wet season has already set in, it is impossible to adopt method A. Secondly, selection of the method must be made corresponding to the type of the said forest stand and the relative difficulty of regeneration. For the uniformed forest of large diameter class having relatively sparse vegetation, method A would be more suitable. For the forest stand of a multiple stories with many small and medium diameter classes or the forest stand

for which regeneration is considered relatively easy judging from soil conditions and the condition of the ground vegetation, method B would be more advisable.

Comparison of the type of operation and the timing of operation between the existing selection system and the seed-tree system just mentioned above is shown in the following table (Fig. 10).

Fig. 10 Natural regeneration method for pine forest

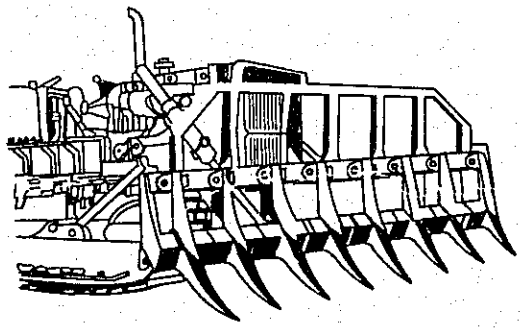


Details of the two methods and the points to be given special attention are as follows:

(1) Burning of forest ground should not be given as a rule to prevent the run-off of soils and to maintain fertility of soils.

(2) For pretreatment of site, soil raking and clearing of under-growth should be provided with the use of tractors. In view of soil condition and anticipated dry season in Kirirom, complete stripping of ground vegetation by dozer or plowing by plough is not advisable but instead the tripe raking by rake dozer or similar machinery is more preferable. Use of a rake slightly wider than conventional rake is advisable (See Fig. 11).

Fig. 11 Rakedozer



(3) Raking by tractor should be made along the contour line as practically as possible. Raking density should be as follows:

500 m/ha (20 m intervals) for method A
300 m/ha (33 m intervals) for method B

The above density will be used as the minimum standard.

(4) It is necessary to avoid the stripe raking by pretreatment as much as possible in arranging roads for tractors for timber skidding after cutting (This is because the work road has the effect similar to the soil raking).

(5) Pine trees of small and medium diameter class, which are below the standard of commercial trees (less than 30 cm in diameter) are to be preserved. Particular care should be exercised so as not to damage these trees when cutting trees of large diameter class.

(6) Seed trees to be preserved must be selected from healthy trees having a diameter of 30 cm or more, with a form good and free from insect and fungi damage. Selection of seed trees should be reserved so as to make uniform distribution over the entire area of regeneration.

(7) Though it is desirable that the required number of seed trees is as large as possible within the range that will not hamper natural regeneration, the minimum standard should be about 10/ha (at approximately 30 m intervals) for the seed tree having DBH diameter of 30 - 60 cm and a height of 20 - 30 m with method A and about 20/ha (at about 22 m intervals) with method B.

(8) Care of regeneration in the initial stage of establishment should include removal of vines, weeds and broad-leaved trees, which should be provided in the first, third and fifty year as a standard. Where there is a thick vegetation of copse it may become necessary to shorten this cycle. However, judging from the present state of Kirirom pine forest, it seems that there is less possibility for thick vegetation of copse.

(9) As stated previously, choice of method between method A and method B should be made depending on the cutting period, forest type and relative difficulty of natural regeneration. In any event, pretreatment of site by tractor should be completed prior to the falling of seeds from mother trees.

The past discussion dealt with natural regeneration method for Kirirom pine forest. The most important thing to obtain success in natural regeneration is to take up the question of regeneration and cutting operation by interrelating each other.

3-4-4 Artificial Regeneration of Kirirom Pines

Generally speaking, regeneration of Kirirom pine can be fully attained with the natural regeneration method as stated previously. With the natural regeneration method, however, it is very probable to see some area where the result of regeneration is not satisfactory owing to the topography or local conditions. It will be necessary, therefore, to provide partial planting in the future. It will also be necessary to expand Kirirom pine to the adjoining area and to make use of it as a leading species for silviculture in Cambodia, as will be mentioned below.

For this reason, it is considered essential to make a further study on the technique of artificial regeneration and gain experiences in silviculture in the plateau of Kirirom, the native land of Kirirom pines. The following may be pointed out as important factors in implementing experimental artificial planting of pines in Kirirom.

(1) Establishment of nursery in the forest

The nursery of small scale will be sufficient for the beginning because the first step should begin with a temporary nursery in the forest. The nursery should be established in the forest stand of relatively sparse plantation where management of nursery is convenient.

(2) Collection of wild seedlings and planting

In Kirirom regeneration of pines in group is seen at roadside and in the part of the forest. Experiments should be made on artificial planting by collecting and nursing these wild seedlings.

(3) Seed collection, nursing of seedlings and planting

For the expansion of Kirirom pine forest, or for planting for the portion where the result of natural regeneration is not satisfactory, well planned and systematic experiments on afforestation must be provided.

Collection and preparation of seeds, germination test, nursery practice and method of planting should be established systematically for practical purpose.

Incidentally, collection of pine seeds in Kirirom is considered to be accomplished with relative easiness.

(4) Introduction of foreign seeds

For the plateau of Kirirom, the Kirirom pine which is native to this region seems to be most suitable but the same Pinus merkusii seems to show quite different characteristics when the seeds of different origins are used. It is important, therefore, to obtain seeds from Sumatra, Thailand and from different part of Cambodia for comparison of their characteristics. It will also be of great importance to make comparative studies by planting such species as Pinus insularis and Pinus caribaea,

which are considered possible in the tropical zone.

3-4-5 Expansive afforestation of Kirirom pine

In the plateau of Kirirom there also are broad-leaved forests and a mixture of broad-leaved forest and pine forest along with a vast pine forest. In the area surrounding the plateau there are also extensive forest stands representing semi-humid forest and dry forest. There is a possibility, therefore, for the afforestation of pines in these areas in addition to the natural regeneration of the existing pine forest.

The broad-leaved forest or a mixed forest of broad-leaved trees and pine seen in the plateau of Kirirom are of the same nature as those generally seen in mountains and highlands in Cambodia but immediate conversion of these forests to pine forests by means of natural regeneration method will confront many difficulties. However, the conversion may be accomplished with relative easiness and certainty if artificial afforestation method is to be used. With the natural regeneration method, considerably a long period is required for regeneration, and moreover separate planning must be made not only for the abovementioned pretreatment of site under the seed-tree system but also for the manipulation of under-growth by strip burning and strip raking.

Also in the area adjacent to Kirirom afforestation of pine is conceivable. Particularly, in the semi-humid forest or dry forest at the foot of the plateau, where Thbeng (Dipterocarupus obtusifolius) is growing, artificial plantation of pine is considered possible with relative easiness judging from the climate, soil conditions and the present forest type. Once a pine forest is created, its preservation is also considered possible in the future by means of natural regeneration. It is estimated that in Cambodia there exist quite an extensive land suitable for pine forest.

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NOTE:

Though there were changes in the names of Canbodian state and some regions after the return to Japan of the survey team, this report used the designation that was in use at time of the survey.

ANNEX

1. Outline of Malayan Uniform System[11]

Symbol	Operation	Sequence
GCL (pre-F)	Poison girdling of dense-crowned trees of middle or lower storeys and if necessary of occational uneconomic upper story trees and cutting and poisoning of climbers	n-7 to n-2 (following good seed year only)
B	Bertam cradication (where necessary)	not less than n-3
LSM	Milliacre sampling of regeneration and location of Heavy Hardwood areas	n-1½ to n-½
EN.	Enumeration of big trees	
F	Final felling (not to continue for more two years)	n to n + 1
GCL	Poison girdling of unwanted trees and cutting and poisoning of climbers	immediately after F
CG $(HHW)_1$	Heavy Hardwood designated area only: 3 ft. leaf-to-leaf eleaning and climber cutting in favour of HHW regeneration and poisoning of climbers	n + 2 to n + 3
CG $(HHW)_2$	Heavy Hardwood designated area only: Repeat of n + 2 to n + 3 operation plus thinning of 5-10 ft. tall HHW saplings with 4 ft. stick and 10 ft. tall with 6 stick	n + 4 to n + 5
LS½	Non-Heavy Hardwood areas: Quarter-chain square sampling of saplings (Not a vital sampling in known rich forest) No treatment (very unlikely) or treatment immediately consisting of any of following:	n + 4 to n + 5 LS¼
C	(i) Cleaning in the undergrowth and climber cutting and poisoning	
CL	(ii) Climber cutting and poisoning only	
G	(iii) Poison-girdling of unwanted trees (relics and commercial trees of bad form)	

Symbol	Operation	Sequence
PL	(iv) Planting of gaps including direct *sowing*	
GCL (HHW)	Heavy Hardwood designated area only: Treatment if necessary to maintain supremacy of HHW canopy. No cleaning in undergrowth.	n + 6 to n + 7
GCL (HHW)	Heavy Hardwood designated area only: Poison-girdling of undesirable competition and climber cutting and poisoning	n + 10
LS½	Non-Heavy Hardwood areas: Half-chain square sampling of saplings and advance growth. (An essential sampling.)	n - 10
Treatment	No treatment (very unlikely); alternatively treatment of any of (i-iv) under LS¼ above and limited selective improvement	immediately after LS½
R	Passed as regenerated if percentage stock at half-chain square sampling 60%	immediately after treatment
LSR (20) LSR (35) etc.	Half-chain square sampling of new crop	n + 20 and at approximate intervals of 10 - 15 years. Thinning schedule not yet decided on.
Treatment	No treatment; alternatively thinning, or climber cutting and poisoning, or poison-girdling of undesirable competition.	immediately after sampling

* Wyatt-Smith, J. · Panton, W.P., Mitchel, B.A.:
Manual of Malyan silviculture for inland forest. Malayan Forest Records, 23, 1963

2. Outline of Linear Sampling Method on the State of Regeneration Under Malayan Uniform System

Type	Description	Evaluation of Regeneration
LSM	Measurement is made by aligning sampled quadrats 1/10 chain square (1/1000 acre) along the survey line for every 5 - 10 chain (one chain equals 66 feet).	Cutting starts when there is satisfactory distribution of usable seedlings and saplings in 30% or more of the sampled quadrats. When the distribution is less than 30% cutting is postponed (re-survey 3 or 5 years later) or enrichment planting is provided.
LS¼	Measurement is made by aligning sampled quadrats ¼ chain square (1/160 acre) along the survey line as in the above case.	When the distribution of seedlings and saplings of usable trees is in 50% or more of the sampled quadrats, the regeneration is judged as satisfactory. When the distribution is less than 50%, tending or enrichment planting is provided.
LS½	Measurement is made by aligning sampled quadrats ½ chain square (1/40 acre) along the survey line as in the above case.	When the distribution of seedlings and saplings of usable trees is in 60% or more of the sampling quadrats, the regeneration is rated as satisfactory. When the distribution is less than 60%, tending or enrichment is provided.

* Wyatt-Smith, J., Panton, W.P., Mitchel, B.A.: Manual of Malayan Silviculture, Malayan Forest Records, 23, 1963

3. Sequence of Operations Under Enrichment Planting System Examples of Kapur (Dryobalanops aromatica) forest*

Year	Operations	Required No. of trees per acre
N	Enrichment planting	160 (400/ha)
N + 1	Enumeration, girdling and clearing, if necessary	130
N + 5	LS¼ method, girdling, clearing and removal of vines	90
N + 10	LS½ method, "	80
N + 20	Thinning	40
N + 40	"	30 (75/ha)
N + 60	Final cutting	–

* Ismal Haji Ali: Enrichment planting in Selangor, Malayan Forester 27 (1), 1964

4. Pinus merkusii

4-1 Outline of Planting Practices

1. Nursery techniques

1) Seeds

(1) Silvicultural characteristics of Pinus merkusii varies greatly depending on the provenance of seeds. Those having their origin in continental highland such as Thailand and Cambodia are not satisfactory for planting in tropical humid area such as Indonesia and Malaysia and the acceptable species is said to be the one native to North Sumatra. Particularly the variety native to Tapanuli (North Sumatra) is said to be the best with good tree form and thin bark.

It is very important, therefore, to give full consideration to the origin of seeds.

(2) Time of cone ripening is from March to June and seeds are collected from the forest stand of good quality.

(3) The number of seeds per kg is 50,000 to 60,000.

(4) Germination rate is 80% or more under favorable conditions but vitality decreases quickly after cropping under normal condition. When stored in sealed containers and kept in low temperature and dry, the vitality may be maintained for several years.

2) Seeding

(1) The amount of seeds required per m^2 is about 50 gr. The nursery should

be provided with shades and protected from dry-up by means of surface covering and sprinkling of water. Immersion of seeds in cold water for a full day prior to sowing will accelerate germination.

(2) For the growth of Pinus merkusii mycoriza is indispensable. For the nursery which has long been used as the nursery for pinus merkusii, the growth of Mycorriza should be sufficient and therefore no special treatment is required. For new nursery, however, it will be necessary to plant a seedling which already bears Mycorriza at the center of the bed or to mix soils containing Mycorriza with the soil of the nursery.

3) Transplanting

(1) Seedlings grown to a height of about 5 cm (about 6 weeks later) is transplanted to other bed with a spacing of 10 x 10 cm or 12 x 12 cm.

(2) Surface covering, shade and sprinkle of water are to be provided as necessary to prevent dry-up of nursery.

4) Out-planting

(1) After the lapse of 8 months the seedlings grown to a height of 20 to 25 cm are taken out for planting in the field.

(2) Seedlings must have their roots covered with earth. For this purpose fern leaves, lalang grass (Imperata spp.) or bamboo pot are to be used. Planting out of seedlings with naked roots will result in unsatisfactory planting.

5) Size of nursery

(1) One ha of nursery is said to be able to produce about 400,000 seedlings per year and the required seeds are said to be about 30 kg in weight. It seems, however, that there is a great fluctuation depending on the degree of intensity of nursery management and the level of nursery technique.

2. Plantation Techniques

Two methods are generally used for afforestation, namely the Taungya method (inter-cropping method) and ordinary planting method (plantation in vacant lots after shifting cultivation or reforestation). In West Java the Taungya method is mainly used. In Sumatra silviculture was seen mainly in the vacant lots after shifting cultivation (In many cases these lots are covered with lalang grass) and the regeneration in the existing forest area after cutting was also observed in part. The cost of silviculture with the Taungya method is said to be about one half of that with the ordinary planting method.

1) Taungya method

(1) Intercropping is usually provided for two years and main crops cultivated are dry land paddy, peanuts and maize. Planting is made at the beginning of the wet season after removal of remaining vegetations following the clear cutting, and after cultivation and preparation of planting rows.

(2) Spacing of planting is 3 x 1 m and about 3,000 seedlings are often required per ha. In some cases shade trees as Erythrino lithosperma or Leucaena glauca are planted between the rows.

2) Ordinary planting method

(1) For planting in the grassland after shifting cultivation, the spacing of planting is 3 x 3 m and in many cases about 1,000 seedlings are required per ha.

(2) For land preparation, spot clearing is provided for planting and the weeding is provided for the spot one meter round the seedling on the basis of six times in three years. The planting hole is to be 30 cm in diameter and about 30 cm in depth. The seedling must have its root covered with earth.

3) Thinning, final cutting and yield

Final cutting age for pulp wood is 25 to 30 years and the thinning is provided about twice as a standard. For details of yield, see yield tables.

4) Mixed planting

As a measure to prevent forest fires, a 25% mixed planting of Macadamea hildobrandii is provided sometimes. Also, under planting of usable trees (such as ebony) is being tried.

(Note) Outline of planting practices for Pinus merkusii in Indonesia, particularly in West Java (Bogor, Sukabumi and Bandung districts) and in North Sumatra (Shantaru, eastern coast of Lake Toba) on the basis of the result of the recent survey and with reference to the following bibliographies.

Soediarto warsopranoto: Recent data and problem of pines in connection with investment prospects on forest industries in Indonesia, Forest Research Institute, Bogor, Indonesia, 1967.

F.A.O. Tree planting practices in tropical Asia, Rome, 1957.

4-2 Yield Table (Indonesia)

Extracts from J.H.A. Ferguson; Growth and yield of Pinus merkusii in Indonesia (1954)

I Yield by site class

Age	Site Class II			Site Class III			Site Class IV			Site Class V			Site Class VI		
	Number of stem	Volume of main stand per ha m^3	Volume of thinning per ha m^3	Number of stem	Volume of main stand per ha m^3	Volume of thinning per ha m^3	Number of stem	Volume of main stand per ha m^3	Volume of thinning per ha m^3	Number of stem	Volume of main stand per ha m^3	Volume of thinning per ha m^3	Number of stem	Volume of main stand per ha m^3	Volume of thinning per ha m^3
5	945	0	-	945	0	-	945	11	-	945	20	-	945	36	-
10	945	37	-	945	71	-	857	115	10	639	138	47	481	164	89
15	740	126	28	535	154	73	403	182	107	318	209	114	253	238	118
20	417	178	83	321	208	86	253	238	90	205	270	92	170	308	91
25	293	219	66	234	249	66	187	286	66	155	321	66	131	356	67
30	236	248	46	189	283	46	154	322	48	129	360	49	109	397	52
35	205	270	30	165	309	34	135	349	35	113	389	69	95	429	41

II Yield Table for Site Class IV

Age	Number of stems	Total basal area (main stand)	Average diameter (main stand) cm	Average height (main stand) m	Volume (main stand) m^3/ha	Mean annual increment m^3
5	945	5.5	8.5	6.4	11	2.2
10	857	25.1	19.3	13.2	115	12.5
15	403	26.8	29.1	19.8	182	19.9
20	253	27.9	37.5	25.4	238	22.2
25	107	28.4	44.0	30.0	286	22.4
30	154	28.7	48.7	33.5	322	21.4
35	135	29.0	52.3	36.2	349	20.1

4-3 Silviculture Accounting

This is not an attempt to obtain accurate figures on the silviculture expenses and earnings but rather to provide fragmentary information on silviculture expenses and earnings.

In Java planting of Pinus merkusii is presently provided by the Taungya method as in the case of teak and Agathis. With the Taungya method the government leases state forests (In Southeast Asia almost all the forests are owned by governments) to farmers and allows them to cultivate intercrops (dry land rice, maize, peppers, etc.) in return for their service in planting of trees, weeding there. This method is generally used for a period of 2 to 3 years when the weeding is not required.

With the Taungya method, therefore, the only expense in silviculture is the cost of seedlings which is about 2.5 Rp (One Rp is equivalent to about one yen) per seedling.

For additional information, the price of Pinus merkusii seeds is about 1,000 Rp per kg.

Since the planting of P. merkusii in Sumatra does not adopt the Taungya method, the expense includes the costs of site preparation, planting and weeding in addition to the cost of seedlings. In general, required manpower per ha is between 80 to 100 and on the assumption that the per capita wage is 100 Rp, an expense of 8,000 to 10,000 Rp is required per ha.

The cutting age is 30 years and the price of standing timber is 400 Rp per M^3 in the case of pulp wood production.

5. Agathis Loranthifolia

5-1 Outline of Planting Practices

1. Nursery techniques

1) Seeds

(1) Seeds are collected locally from the oldest stands. Viable seeds are not obtained from the forest stand less than 25 of age. Collection of seeds is made during the period from February to April and from August to October.

(2) The number of seeds in one kg is approximately 6,000 and one pine cone bears 30 to 60 seeds, of which only 10 to 25 seeds have vital power.

(3) Germination rate of fresh seeds is as high as 90 to 100% but it decreases to 80 to 90% in one week, 40 to 50% in two weeks and none of them will germinate after six weeks. Decrease of germination rate is very rapid.

(4) Charcoal powder moistened with 1% saline solution is to be mixed with seeds in the ratio of 1 kg of seeds to 3/4 liter of charcoal powder, which are then placed in bags or wrapped with perforated tin foil for storage.

(5) Immersion in cold water for one full day will accelerate the process of germination.

2) Seeding

(1) Seeding is to be made in the seeding bed 5 × 5 cm or 10 × 5 cm in size immediately after the collection of seeds.

(2) Germination begins in 9 to 10 days after seeding. 30% germination is seen in 18 to 20 days. Seeds treated with cold water begin germination in 6 days and attain 80% germination in 10 days after seeding. The foregoing is an example for the highland 1,100 m in elevation and therefore the germination begins much earlies in lowlands.

(3) Sunshade, surface covering and sprinkle of water should be provided immediately after germination.

3) Transplanting

(1) When the seedling attain a height of about 7 cm it is transplanted to other nursery bed with a spacing of 12 × 12 cm.

(2) Use of a bamboo-tube (15 cm high, 7 to 10 cm in diameter, without bottom), bamboo cage (15 - 20 cm × 10 - 15 cm) or a pot (15 cm × 5 xm) containing a mixture of earth and fibers of palm trees is effective.

(3) Transplanting nursery bed is to be protected by planting covering trees (Erythrina lithosperma or Leucaena glauca).

4) Out-planting

(1) Seedling 25 to 50 cm in height and one year to a year and six months in age is planted to forest stands. Those less than 10 cm in height are not to be removed.

(2) Out-planting is to be made when the growth of bud stops. When planting is not made with a pot or a bamboo cage root taking is only 50%.

2. Plantation techniques

1) Land preparation

(1) With the Taungya method, intercropping is provided for a period of one to two years. Type of crops includes maize, dry land paddy, peanuts, etc.

(2) Within a period of January through June removal of remaining vegetation after clear cutting and layout of the inspection path are to be accomplished. In the period of July through September cultivation of land and arrangement of rows for planting are to be accomplished. Planting of shade trees (Leucaena glauca) is done at the end of October.

2) Planting

(1) Planting is made during the period of December to January (Wet season).

(2) When the shading by crops and shade trees is not adequate, fern leaves should be posted around the seedling.

(3) Spacing of planting is to be 1 m × 3 m or 1.5 m × 3 m.

(4) With the taungya method tending in the early stage is greatly reduced by cultivation.

3) Thinning

(1) The first thinning is provided in 6 to 8 years but too early thinning is not advisable.

(2) Thinning is provided in every 3 years during a period up to 20 years, in every 5 years during a period up to 40 years and then in every 10 years thereafter.

Taking into consideration the difficult natural prunning and in connection with its tolerance, thinning should be made gradually and moderately.

4) Final cutting and yield

(1) Final cutting age is 30 years for pulp wood and 50 years for lumber and veneer wood.

(2) For details of yield, see yield tables.

Note * Outline of silviculture in Java based on the observation during the current survey and the following bibliographies.

Soediarto Warsopranoto: Tropical conifers (other than pines) study, report on Agathis Joranthifolia salisb., Forest Research Institute, Bogor Indonesia

5-2 Yield Table (Indonesia)

An extract from Jr. Mursaid, K. Sudarmo.; Preliminary yield table of Agathis loranthifolia Salisb (= A. Alba) (1956).

Age	Upper-height 1) m	Main stand						Thinnings		Total volume	Mean annual increment	Current annual increment
		Relative-spacing 2) (S%)	Number of stems pro ha (N)	Average height 3) (hg) m	Average diameter 4) (g^d) cm	Basal area of total stand pro ha 5) (G) m^2/ha	Volume thick wood pro ha 6) (V) m^3/ha	Volume thick-wood pro ha m^3/ha	Total volume from thinnings m^3/ha	m^3/ha	m^3/ha	m^3/ha
1	2	3	4	5	6	7	8	9	10	11	12	13
						SITE CLASS II = SITE INDEX 27.0 m						
5	5.9	32.9	3112	4.6	5.0	6.1	15	10	10	25	5.0	5.0
10	13.9	22.6	1183	12.5	13.0	15.7	92	32	42	134	13.4	21.8
15	19.6	20.1	742	18.3	20.0	23.3	188	60	102	290	19.3	31.2
20	23.9	19.2	552	23.0	26.0	29.3	279	60	162	441	22.0	30.2
25	27.0	18.8	445	26.4	31.1	33.8	360	55	217	577	23.1	27.2
30	29.6	18.8	372	29.2	35.8	37.5	432	53	270	702	23.4	25.0
35	31.8	18.7	325	31.6	40.0	40.8	498	50	320	818	23.4	23.2
40	33.9	18.6	290	33.9	43.9	43.9	564	46	366	930	23.2	22.4
45	35.5	18.6	265	35.7	47.2	46.3	617	40	406	1023	22.8	18.6
50	36.7	18.5	252	37.0	49.8	49.0	658	35	441	1099	22.0	15.2
						SITE CLASS III = SITE INDEX 30.0 m						
5	6.8	33.2	2105	5.5	6.6	7.2	21	15	15	37	7.4	7.4
10	16.2	20.9	1011	14.4	15.3	18.6	113	51	66	179	17.9	28.4
15	22.2	19.2	634	20.5	23.3	27.0	225	70	136	361	24.1	36.4
20	26.7	18.5	471	25.3	30.1	33.5	331	70	206	537	26.8	35.2
25	30.0	18.4	376	29.0	36.0	38.3	422	60	266	688	27.5	30.2
30	32.8	18.3	321	32.1	41.1	42.6	509	55	321	831	27.7	28.6
35	35.3	18.2	187	34.8	46.1	46.3	584	50	371	955	27.3	24.8
40	37.4	18.2	249	37.2	50.3	49.5	650	46	417	1067	26.7	22.4
45	39.1	18.2	228	39.1	54.0	52.2	705	41	458	1163	25.8	19.2
50	40.4	18.3	211	40.3	57.1	54.1	750	37	495	1245	24.9	16.4
						SITE CLASS IV = SITE INDEX 33.0 m						
5	7.7	33.5	1736	6.6	7.8	8.3	31	15	15	46	9.2	9.2
10	18.5	19.4	896	16.5	17.5	21.6	144	60	75	219	21.9	34.6
15	24.8	18.3	563	23.0	26.4	30.8	276	80	155	431	28.7	42.4
20	29.5	17.8	422	27.9	33.7	37.6	403	75	230	633	31.6	40.4
25	33.0	17.8	335	31.7	40.3	42.7	510	65	295	805	32.2	34.4
30	36.2	17.7	281	35.0	46.3	47.4	606	60	355	961	32.0	31.2
35	38.8	17.8	243	37.9	51.8	51.3	686	56	411	1097	31.3	27.2
40	40.9	17.9	217	40.3	56.6	54.5	757	50	461	1218	30.4	24.2
45	42.8	17.9	196	42.4	61.1	57.5	823	45	506	1329	29.5	22.2
50	44.1	18.1	180	44.0	65.0	59.7	868	37	543	1411	28.2	16.4

1) Upperheight = the average height of the 100 most dominating trees pro ha.

2) S% = relative-spacing =

$$\frac{\text{average distance between trees in the stand}}{\text{upperheight}} \times 100\%$$

(The average space between trees in the stand easily computable from stemnumber pro ha).

5-3 Silviculture Accounting

Planting of Agathis in Java also adopts the Taungya Method. Accordingly, the only expense in Silviculture is the cost of seedlings, which is about 3.5 Rp per seedling.

Against this, the revenue is the proceeds from the sale of lumber which earns from 5,000 to 10,000 Rp per m^3 (price of round wood in the forest) for main lumber of 50 years rotation, price of which varies with the diameter class.

6. Yield Table of Albizzia Falcata (Indonesia)

J. K. Soemarna; A preliminary normal yield-table of Albizzia falcata (1961)

UMUR *Age*	PENINGGI *Upper height*	TEGAKAN-TETAP *Main-stand*						ISI *Volume*				
		Djumlah pohon/ha. *Number of trees/ha.* N/ha.	SS	Diameter rata² *Average diameter* Cm	Tinggi rata² *Average height* m	Djumlah bidang dasar *Total-basal area* m²/ha.	Isi *Volume* m³/ha.	Pendjarangan *Thinnings* m³/ha.	Djumlah pendjarangan *Cumulative thinnings* m³/ha.	Djumlah hasil *Total production* m³/ha.	Riap rata² tahunan *Mean annual increment* m³/ha.	Riap djalan tahunan *Current ann: increment* m³/ha.
SITE CLASS - II - SITE INDEX = 27.5 m												
2	7.2	1252	42.2	8.3	5.7	5.7	10.0	3.2	3.2	13.2	6.6	–
3	11.6	892	30.5	11.8	10.5	7.8	32.0	4.4	7.6	39.6	13.2	26.4
4	16.0	640	26.5	13.7	14.8	9.3	56.5	12.3	19.9	76.4	19.1	36.8
5	19.7	468	25.2	16.7	18.6	10.5	81.3	26.2	46.1	127.4	25.5	51.0
6	22.9	345	25.3	20.1	21.9	11.4	105.2	41.1	87.2	192.4	32.1	65.0
7	25.5	265	25.9	23.8	24.6	12.1	127.1	42.7	129.9	257.0	36.7	64.6
8	27.5	215	26.6	27.6	26.6	12.6	145.0	38.1	168.0	313.0	39.1	56.0
9	29.0	180	27.6	30.8	28.2	12.9	158.3	29.9	197.9	356.2	39.6	43.2
10	30.4	153	28.6	33.9	29.6	13.2	171.2	28.1	226.0	397.2	39.7	41.0
11	31.5	133	29.6	36.5	30.7	13.4	181.8	21.2	247.2	429.0	39.0	31.8
12	32.5	118	30.5	39.0	31.8	13.6	192.0	19.1	266.3	458.3	38.2	29.3
SITE CLASS - III - SITE INDEX = 30.5 m												
2	10.0	1034	33.4	10.0	8.6	7.1	22.5	5.1	5.1	27.6	13.8	–
3	15.4	673	26.9	13.3	14.2	9.1	52.8	12.1	17.2	70.0	23.3	42.4
4	20.1	450	25.2	17.1	19.0	10.6	84.2	33.0	50.2	134.4	33.6	64.4
5	23.9	313	25.4	21.4	22.9	11.6	113.3	52.5	102.7	216.0	43.2	81.6
6	26.8	230	26.4	26.2	25.9	12.4	138.6	51.7	154.4	293.0	48.8	77.0
7	28.8	185	27.4	30.3	28.0	12.9	156 2	39.4	193.8	350.0	50.0	57.0
8	30.5	150	28.7	34.2	29.7	13.2	172.0	34.4	228.2	400.2	50.0	50.2
9	31.7	130	29.1	37.0	30.9	13.5	183.8	23.0	251.2	435.0	48.3	34 8
10	32.7	115	30.6	39.5	32.0	13.7	194.0	19.8	271.0	465.0	46.5	30.0
11	33.7	102	31.7	41.9	33.0	13.9	204.2	19.0	290.0	494.2	44.9	29.2
12	34.5	95	31.9	43.9	33.7	14.0	212.7	15.3	305.3	518.0	43.2	23.8
SITE CLASS - IV - SITE INDEX = 35.5 m												
2	12.7	833	29.3	11.6	11.4	8.2	36.9	9.5	9.5	46.4	23.2	–
3	18.8	505	25.4	15.9	17.7	10.2	75.0	28.1	37.6	112.6	37.5	66.2
4	23.9	313	25.4	21.4	22.9	11.6	113.3	65.1	102.7	216.0	54.0	103.4
5	27.9	205	26.9	28.4	27.0	12.7	148.4	72.9	175.6	324.0	64.8	108.0
6	30.6	150	28.7	34.4	29.8	13.3	173.2	54.2	229.8	403.0	67.2	79.0
7	32.3	120	30.4	38.5	31.6	13.6	190.0	31.6	262.4	452.4	64.6	49.4
8	33.5	105	31.3	41.4	32.8	13.8	202.0	23.4	285.8	488.0	61.0	35.6
9	34.5	96	31.9	43.9	33.7	14.0	212.7	19.5	305.3	518.0	57.6	30.0
10	35.2	90	32.1	45.5	34.5	14.2	220.0	12.7	319.0	539.0	53.9	21.0
11	35.9	84	32.6	47.3	35.3	14.3	227.0	13.0	332.0	559.0	50.8	20.0
12	36.4	80	33.0	48.5	35.8	14.4	232.5	9.5	341.5	574.0	47.8	15.0

7. Yield Table of Authocepholus cadamba (Indonesia)

Ir. Mursoid, K. Soedarmo; Preliminary yield-table of Anthocephalus cadamba miq (Djabon) (1957)

Umur (Age)	Peninggi (Top-height (OH) (m)	Tegakan tetap (T.T.) (Main stand)						Tegakan pendjara-ngan (= T.P.) Thinnings		Dumlah Volume TT+ΣTP (Total volume) m^3/ha	Riap rara² tahunan (Mean annual incr.) m^3/ha	Riap djalan tahunan (Current annual incr.) m^3/ha
		S%	Djumlah batang per HA (number of stem/ha) (N)	Tinggi rate² (Average height) (m)	Diameter rate² (Average diameter) (cm)	Luas bidang dasar (Total-basal area) m^2/ha	Volume kaju tabal (Volume) m^3/ha	Volume kaju tebal (Volume) m^3/ha	Djumlah volume penjha-rangan (Total volume) m^3/ha			
1	2	3	4	5	6	7	8	9	10	11	12	13
Bonita II (Site index 21.0 m)												
3	10.2	36.6	830	9.2	9.6	4.4	23.5	4.5	4.5	28.0	9.3	–
6	14.8	33.9	460	13.7	15.3	7.2	50.0	13.0	17.5	67.5	11.2	13.2
9	17.4	34.0	330	16.3	18.8	9.0	68.5	19.5	37.0	105.5	11.7	12.7
12	19.4	34.0	265	18.2	22.2	10.5	85.5	23.5	60.5	146.0	12.2	13.5
15	21.0	34.5	220	19.8	24.9	11.7	100.0	26.0	86.5	186.5	12.4	13.5
18	22.4	34.5	195	21.2	27.3	12.8	114.0	27.0	113.5	227.5	12.6	13.7
21	23.5	34.6	175	22.3	29.2	13.6	126.0	26.0	139.5	265.5	12.6	12.7
24	24.5	34.7	160	23.3	31.0	14.4	137.5	25.5	165.0	302.5	12.6	12.3
Bonita III (Site index 24.0 m)												
3	12.1	34.5	660	11.0	11.8	5.5	33.0	8.0	8.0	41.0	13.7	–
6	17.2	33.9	340	16.1	18.8	8.9	67.0	19.0	27.0	94.0	15.7	17.7
9	20.2	34.4	240	19.1	23.6	11.1	92.5	25.5	52.5	145.0	16.1	17.0
12	22.3	34.5	195	21.2	27.1	12.7	113.5	25.5	78.0	191.5	16.0	15.5
15	24.0	34.5	170	22.9	30.1	14.0	131.5	25.5	103.5	235.0	15.7	14.5
18	25.4	34.5	150	24.2	32.6	15.2	147.5	24.5	128.0	275.5	15.3	13.5
21	26.6	34.1	140	25.4	34.9	16.1	161.5	24.5	152.5	314.0	15.0	12.8
24	27.6	33.5	135	26.4	36.9	17.0	174.0	22.0	174.5	348.5	14.5	11.5
Bonita IV (Site index 27.0 m)												
3	14.0	33.8	515	12.9	14.2	6.7	44.0	12.0	12.0	56.0	18.7	–
6	19.6	34.0	260	18.5	22.6	10.6	87.0	24.0	36.0	123.0	20.5	22.3
9	23.0	34.3	185	21.8	28.3	13.2	120.5	26.5	62.5	183.0	20.3	20.0
12	25.2	34.2	155	24.0	32.1	15.0	145.0	25.0	87.5	232.5	19.4	16.5
15	27.0	33.6	140	25.8	35.7	16.5	166.5	23.5	111.0	277.5	18.5	15.0
18	28.4	33.2	130	27.2	38.5	17.7	183.5	21.5	132.5	316.0	17.6	12.8
21	29.7	33.0	120	28.5	41.2	18.8	200.0	19.0	151.5	351.5	16.7	11.8
24	30.7	32.6	115	29.5	43.4	19.6	212.5	16.5	168.0	380.5	15.9	9.7

8. Yield Table of Swietenia Macrophylla (Indonesia)

Dr. H. L. Wolf von Wiilfing; Preliminary yield-table for Altingia encelsa, Dalkergia latifolia, Ochroma bioolor, Swietonia macrophylla, (1949)

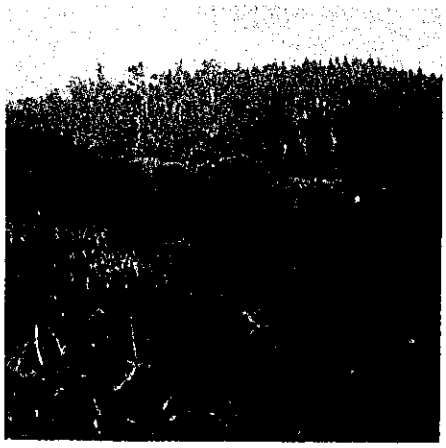
Age year Umur tahun	*Siteclass I* Bon. I				*Siteclass II* Bon. II				*Siteclass III* Bon. III			
	S%	*(Stem Number pro ha)* N	*(Main stand)* Tegakan tinggal m3	*(Thinnings)* Pendjarangan m3	S%	*(Stem Number pro ha)* N	*(Main stand)* Tegakan tinggal m3	*(Thinnings)* Pendjarangan m3	S%	*(Stem Number pro ha)* N	*(Main stand)* Tegakan tinggal m3	*(Thinnings)* Pendjarangan m3
5	35.9	2410	5	1	38.2	2073	13	5	24.8	1955	33	15
10	23.4	1804	44	10	21.0	1164	90	43	21.5	684	166	187
15	21.2	1258	88	25	21.3	729	159	58	23.4	392	255	115
20	21.0	876	133	36	22.5	499	218	60	24.4	298	314	60
25	21.8	618	180	46	23.6	375	272	55	25.0	250	362	42
30	22.8	467	223	44	24.3	305	318	44	25.4	219	401	34
35	23.6	375	264	39	24.8	263	354	34	25.7	197	435	29
40	24.1	321	299	30	25.2	234	386	29	26.0	179	465	28
45	24.6	282	328	27	25.5	211	415	27	26.2	164	490	27
50	24.9	256	355	22	25.8	194	442	26	26.5	152	514	25
55	25.2	234	379	22	26.0	180	468	22	26.8	142	536	23
60	25.4	217	401	19	26.2	168	492	21	26.9	134	557	20

(1) enrichment planting
(Malaya)

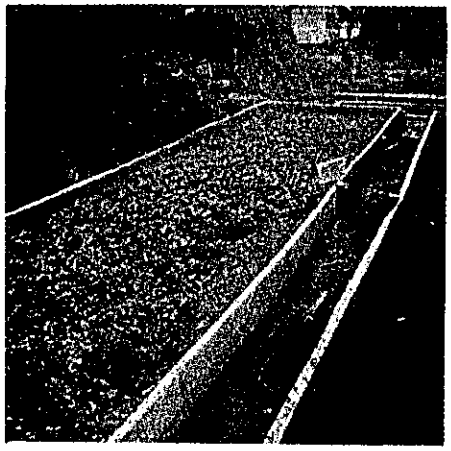
(2) enrichment planting
(Malaya)

(3) Jeltong . Dyera costulata
(seedling for transplanting)
(Malaya)

(4) Jeltong . Dyera costulata
(young tree of 1.5 years of age)
(Malaya)



(5) Taungay system (Java)



(6) P. merkusii (seed bed) (Java)

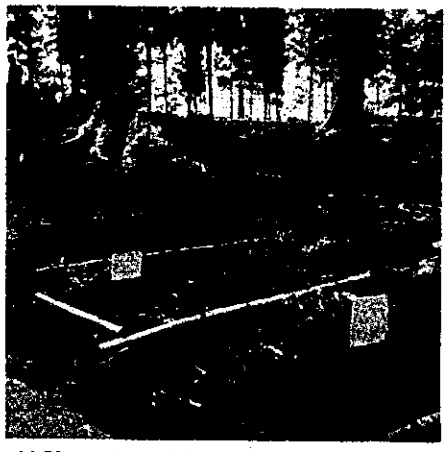
(7) P. merkusii (transplanting bed) (Java)

(8) P. merkusii (seedlings for transplanting) (Java)

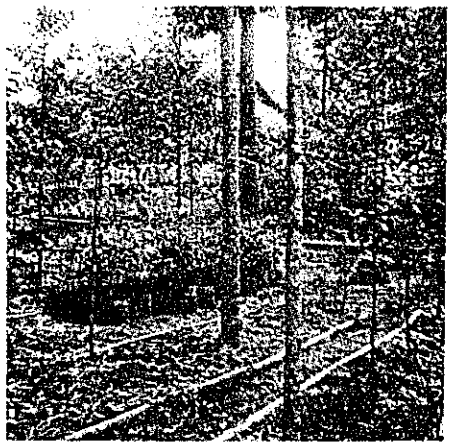
(9) P. merkusii (plantation at 17 years of age)
(Java)

(10) P. merkusii (plantation at 37 years of age)
(Sumatra)

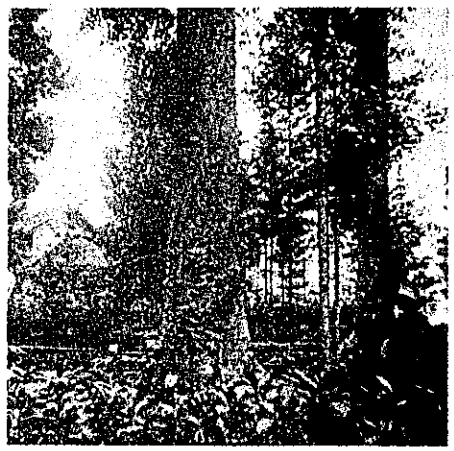
(11) P. merkusii (log for export)
(Sumatra)



(12) Agathis loranthifolia
(seed bed)
(Java)

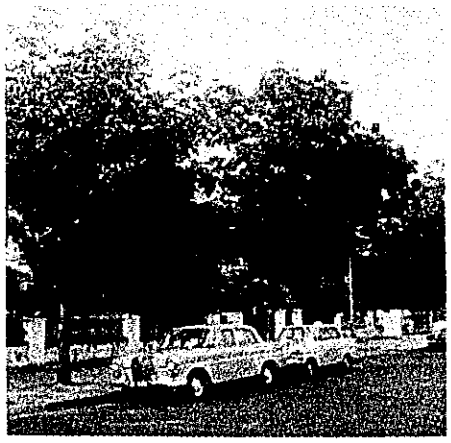


(13) Agathis loranthifolia
(seedling for transplanting)
(Java)

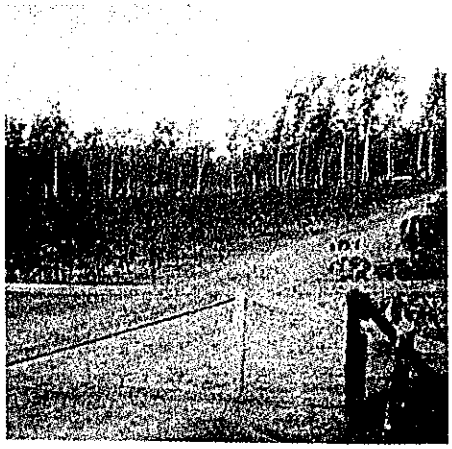


(14) Agathis loranthifolia
(mother trees at 50 years of age)
(Java)

(15) Swietenia macrophylla
(wayside trees)
(Sumatra)

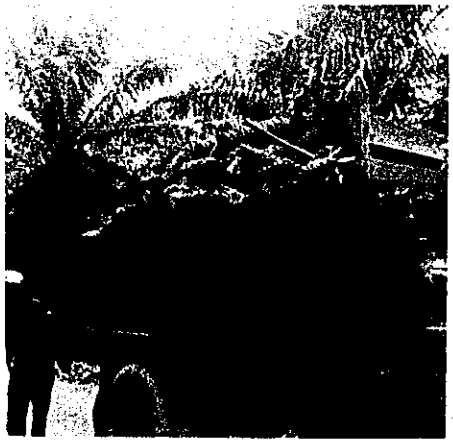


(16) Swietenia macrophylla
(wayside trees)
(Phnom-penh Cambodia)



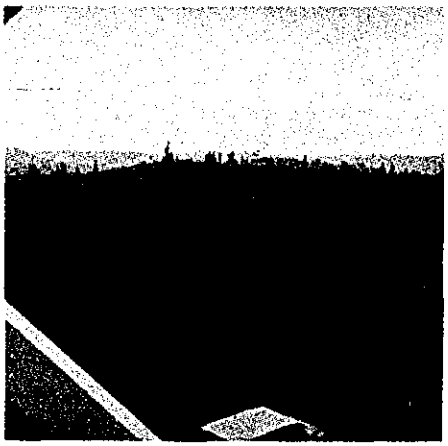
(17) Hevea brasiliensis (plantation)
(Sumatra)

(18) Elaeis guineensis (plantation at 14 years of age)
(Sumatra)



(19) Elaeis guineensis (transportation of fruits)
(Sumatra)

(20) Elaeis guineensis (fruit)
(Sumatra)



(21) Pinus hondurensis (plantation) (Malaya)

(22) Pinus hondurensis (plantation) (Malaya)

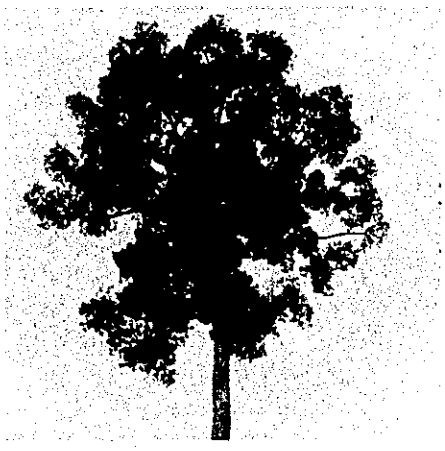
(23) Pinus merkusii (natural forest) (Kirirom Cambodia)

(24) Pinus merkusii (natural stand) (Kirirom Cambodia)

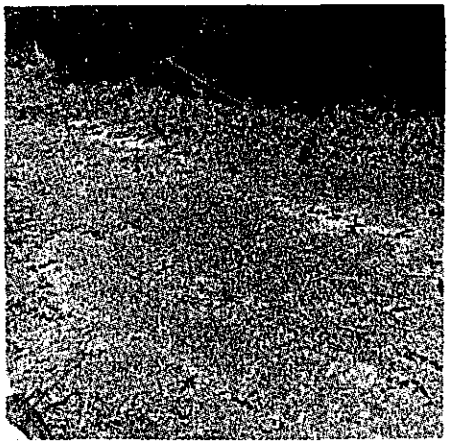
(25) Pinus merkusii (raft of log)
(Phnom-penh Cambodia)

(26) Pinus merkusii (shipping of log)
(Phnom-penh Cambodia)

(27) natural forest in the coast area
(Cambodia)



(28) Chhoeuteal . Disterocarpus costatus
(Cambodia)



(29) Koki-Phnong . Shorea hypocha (seed) (Cambodia)

(30) Chhoeuteal . D. dyera (natural seedling) (Cambodia)