No. 1

THE MULTI-STORIED FOREST MANAGEMENT PROJECT IN PENINSULAR MALAYSIA

The Multi-Storied Forest Management Project in Peninsular Malaysia

- Interim Report -

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June 1994

Japan International Cooperation Agency (JICA)

Interim Report

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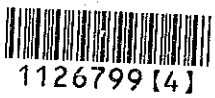
INTRODUCTION

The Multi-Storied Forest Management in Malaysia is part of the developmental cooperation, whereby the objective is on the promotion of regional development by establishing a Multi-Storied Forest Management System for tropical forests with advanced environmental conservation functions and encouraging Japan's private sector to implement cooperation projects in forestry development. The various investigations have been implemented since the approval of the Record of Discussions on October 11, 1991, and the conclusion of a memorandum concerning the implementation plan on November 2, 1993.

This interim report is a compilation of the results of investigations carried-out over the past 2 years and 7 months in order to enhance the efficiency of future field demonstrational investigations. We would like to express our deepest gratitude to those persons of the Malaysian and Japanese sides who had cooperated in the preparation of this report:

Japan International Cooperation Agency (JICA)
Director: Toshiro Taguchi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FOREWORD

I am deeply honoured to be given the opportunity to write a few words in the FOREWORD of this interim report. This interim report is not only timely but appropriate as it provides the opportunity to assess the progress and achievement of the **Multi-Storied Forest Management Project In Malaysia** since its implementation in November, 1991.

This project which is a five-year technical cooperation project between the Governments of Malaysia and Japan is located in the state of Perak. The aims of the project are (l) to examine the conversion of the present man-made forest as well as logged-over natural forest into a multi-storied forest, and (2) to determine some promising high quality indigenous tree species through the combination of belt/patch formation for man-made forest and/or natural forest for multi-storied forest establishment.

In the current worldwide concern for the sustainabilty of tropical forest resources as well as the conservation of biological diversity, the implementation of this project is most timely as it will contribute towards the refinement of forest management practices for both the tropical and plantation forests. In addition, the establishment of multi-storied forests could also enhance biological diversity in the forest ecosystem as against even-aged plantation.

I am happy to report here that much progress has been achieved in the project implementation. In this respect, I would like to record my thanks to the Japanese government for funding the project as well as in providing technical expertise, notably in the field of nursery, silviculture, forest management and forest machinery. Their expertise have contributed significantly towards the implementation of the project. In addition, their provision of training for forestry department staff in Japan have also rendered momentum to the project implementation and enhanced the process of technology transfer.

The documentation of this interim report represents a significant step in the on-going process of developing sustainable forest management in Malaysia. The findings of the project would go a long way and contribute towards a better understanding of the complexities of managing tropical forest resources. Valuable experience gained from this project would further enhance and improve forest management practices in Malaysia. It is my fervent hope that this project will be implemented succesfully and that all the goals and objectives of the project will be fully achieved by the end of the project implementation in October, 1996.

DATO' ISMAIL BIN AWANG
Director-General of Forestry,
Peninsular Malaysia.

EXECUTIVE SUMMARY

The Multi-Storied Forest Management Project in Malaysia was materialized as a result of the Record of Discussions between The Japanese Implementation Survey Team and the Authorities concerned of the Government of Malaysia which was signed in October 11, 1991. The purpose of the project is to collect useful data for establishing a Multi-Storied Forest Management System in the tropics, which will contribute to the promotion of reforestation/afforestation by the private sector and sustainable development of the forest in the tropics.

Multi-Storied Forest Management System is a management system which is developed in order to create a mixed forest of complex structure for environmental consideration, resistant to pests and diseases and conducive environment with diversified timber production.

The duration of the project is 5 years and ends on October 31, 1996. Two sites were chosen for the project i.e. Chikus Forest Reserve and Bukit Kinta Forest Reserve with an area of 500 hectares and 500 hectares respectively. The Chikus Forest Reserve site comprises 3-4 years old *Acacia mangium* plantation while the Bukit Kinta Forest Reserve site comprises of logged-over natural forest.

This interim report is to assess the progress and achievement of the Multi-Storied Forest Management Project in Malaysia since its implementation in November, 1991.

The project consists of 4 major components viz., Nursery, Silviculture, Forest Management and Forest Machinery.

The long-term experts and local counterpart officers in the field of Silviculture, Forest Management, Nursery and Forest Machinery were dispatched to ensure that the project will progress well as planned.

Infrastructure, building and other facilities required for the running of the project were constructed and acquired in Bukit Kinta Forest Reserve and Chikus Forest Reserve sites. Aside from this, vehicles and equipment such as 4-wheel drive vehicles, excavators, soil mixers, fork lifts, cargo trucks, dump truck and etc. were made available for the project.

A nursery with an area of 20,000 m.^{2} was constructed in June 1992 and 1993 which has a total of 120 seedbeds with a capacity of 160,000 seedlings i.e. requirements for 100 hectares of planted area annually. The seedlings were either raised from seeds or wildings especially for the high quality indigenous species such as *Shorea leprosula*, *Shorea parvifolia*, *Hopea odorata* and *Dipterocarpus cornutus*. With the formation of Flowering/Fruiting Information Network enable the success of seeds collection of high quality indigenous species and thus enhanced the project effectiveness in the reafforestation.

The seedlings production for the year 1992 and 1993 was 252,000 with the size of 30 cm. to 60 cm. in height before transplanting which were kept in Chikus Nursery. The amount of seeds that could be collected from a mother tree of high quality indigenous species ranges from 10,600 to 35,100 and the survival rates of the wildings were 43% to 59% in the nursery.

In the Chikus nursery, various types of experiments were conducted to facilitate the project such as species selection, seedling and wilding production, vegetative propagation, pest and diseases damages, and also the flowering inducement and phenological observation in the field.

In the illuminance and shade experiment, it has indicated that 25% - 70% illuminance was the most favourable condition for the survival and growth of most indigenous species and is suited for line-planting in the field. Whereas in the optimum pot size experiment, it was found that larger pot sizes were most favourable and effective for seedlings production of roughly 10 cm. in height. Also, it was found that 7 out of 14 species planted from cuttings survived in this experiments which implies its potential for use in large-scale seedlings production.

Until this interim report was published, a total of 255 hectares (46% achievement) of Multi-Storied Forest were established with a total of 36 species comprising of 16 species Dipterocarps and 20 species Non-Dipterocarps. Out of this, 126 hectares were established in Chikus Block-A (110 hectares for Multi-Storied Forest planting and 16 hectares for arboretum planting) and 122 hectares in Chikus Block-B solely for Multi-Storied Forest planting and 7 hectares of Multi-Storied Forest planting in Bukit Kinta site.

In Chikus site, Multi-Storied Forest is comprised of fast-growing *Acacia mangium* and high quality indigenous species planted together in five (5) different patterns i.e. 1, 2, 4, 8 or 16 alternating rows of *Acacia mangium* and high quality indigenous species. Whereas in Bukit Kinta site, a Multi-Storied Forest is established through enrichment planting of high quality indigenous species on gaps created in logged-over natural forest. Aside from this, an arboretum consisting of 21 different species (50 species to be planted) was established mainly to collect physiological and ecological data for these species.

Early observation showed that survival rate was relatively low (16% - 45%) in clear-cut/open land for most species studied except for *Hopea odorata* mainly due to high temperature, over-exposed and insufficient hardening of the planted seedlings.

In establishing Multi-Storied Forest in existing man-made forest (*Acacia mangium* plantation), for three (3) species studied i.e. *Shorea parvifolia*, *Shorea leprosula* and *Neobalanocarpus heimii*, showed that survival and growth rates one year after planting were better in plots with narrow gaps (2:2 and 4:4 cutting patterns) where relative illuminance were 30% - 70%. The conclusion for this is that *Acacia mangium* serves as nurse trees and also provide shade to dipterocarps (indigenous species) at an early stage of the development (growth).

Various Multi-Storied Forest Management models can be developed based on this preliminary results. As an example, Model I (3-Storied Type): *Acacia mangium* (short-rotation species) as upper trees and *Shorea parvifolia* and *Shorea leprosula* (long-rotation species) as lower trees. Also, Model II (4-Storied Type): same as Model I but medium rotation species such as *Tectona grandis*, *Khaya ivorensis* and *Swietenia macrophylla* will be introduced/planted mainly to provide income before long-rotation species can be harvested. Final model of Multi-Storied Management will be developed which can suit commercial large-scale Multi-Storied Forest. This must be studied and verified with cost analysis.

Preliminary analysis showed that Multi-Storied Forest Management Project cost establishment is highest when compared to indigenous species plantation and man-made plantation (*Acacia mangium*) i.e. RM 4,833/ha., RM 3,000/ha. and RM 2,000/ha. respectively.

However, final analysis of costs from site preparation, seedling production planting, silvicultural operation, road construction and maintenance, etc. will be included in the final report at the end of the project.

CONTENTS

I Project Overview

1 Step of Project

1-1 Demonstrational Project: Background And Objectives

The 1980s saw an increasing awareness of the importance of sustainable development in light of the rapid deforestation of the world's forests, including tropical rainforests. Needless to say, rainforests represent an important resource not only for the country in which they exist, but for other countries as well.

However, it is also a fact that the pace of afforestation is far behind the rate at which the rainforests are disappearing, and despite the steady progress being made in afforestation projects implemented by each nation independently and through bilateral projects, international organizations and NGOs, etc., such projects are extremely limited in scale.

In addition, most of the large-scale afforestation project being implemented commercially around the world involve fast growing species for use in the production of pulp and wood chips.

While the planting of fast growing species does to a certain extent contribute to forestry conservation and afforestation efforts in tropical rainforests, the private sector must adopt commercial forestry methods that better serve the public interest (in such areas as water resource development and landslide prevention) as part of better environmental conservation in the future.

Multi-Storied Forest Management - the planting of different species of trees within the same area in order to create a mixed forest of complex structure - lacks the shortcomings of single-species afforestation and results in forests that are effective in environmental conservation, resistant to pests and diseases, and conducive to diversified timber production.

However, lack of technological knowledge in such forest management system in nations with tropical rainforests has hampered the application of said system in commercial afforestation.

Hence, the objective of this demonstrational project is to examine the conversion of the present man-made forest as well as logged-over natural forest into a multi-storied forest and to determine some promising high quality indigenous tree species through the combination of belt/patch formation for man-made forest and/or natural forest for multi-storied forest establishment.

1-2 The Process Up To Conclusion Of Record Of Discussions

1) Primary Basic Survey
(Oct. 9 - Oct. 30, 1990, Team leader: Kazuya Sadachi, Number of team members: 5)
As a result of discussions with related organizations in the three countries (Malaysia, Thailand and Papua New Guinea) that were visited, Malaysia was selected as the site of project implementation.

2) Secondary Basic Survey
(Jan. 27 - Feb. 10, 1991, Team leader: Kazuya Sadachi, Number of team members: 5)
This team was dispatched to inspect proposed sites, to decide on basic policies, and to present the Record of Discussions proposal to the Malaysian side.

3) Plan Coordination Team
(Jul. 7 - 18, 1991, Team leader: Yasuo Ohsumi, Number of team members: 4)
This team was dispatched to draft and discuss the basic plan and measures to be taken by Japan and Malaysia upon project implementation.

4) Plan Coordination Team
(Oct. 3 - 13, 1991, Team leader: Masanori Tanaka, Number of team members: 4)
This team was dispatched to discuss and finalize the Record of Discussions and Tentative Schedule of Implementation and to participate in the signing of said documents which was held on 11 October 1991 between the Director-General of Forestry Department, Peninsular Malaysia and the team leader. Consequently the starting date of project implementation was finalized as 1 November 1991.

5) The Dispatch Of Investigators
Three investigators were dispatched at the same time for a period of approximately one month to draft an experimental plan, project plan, and equipment plan.

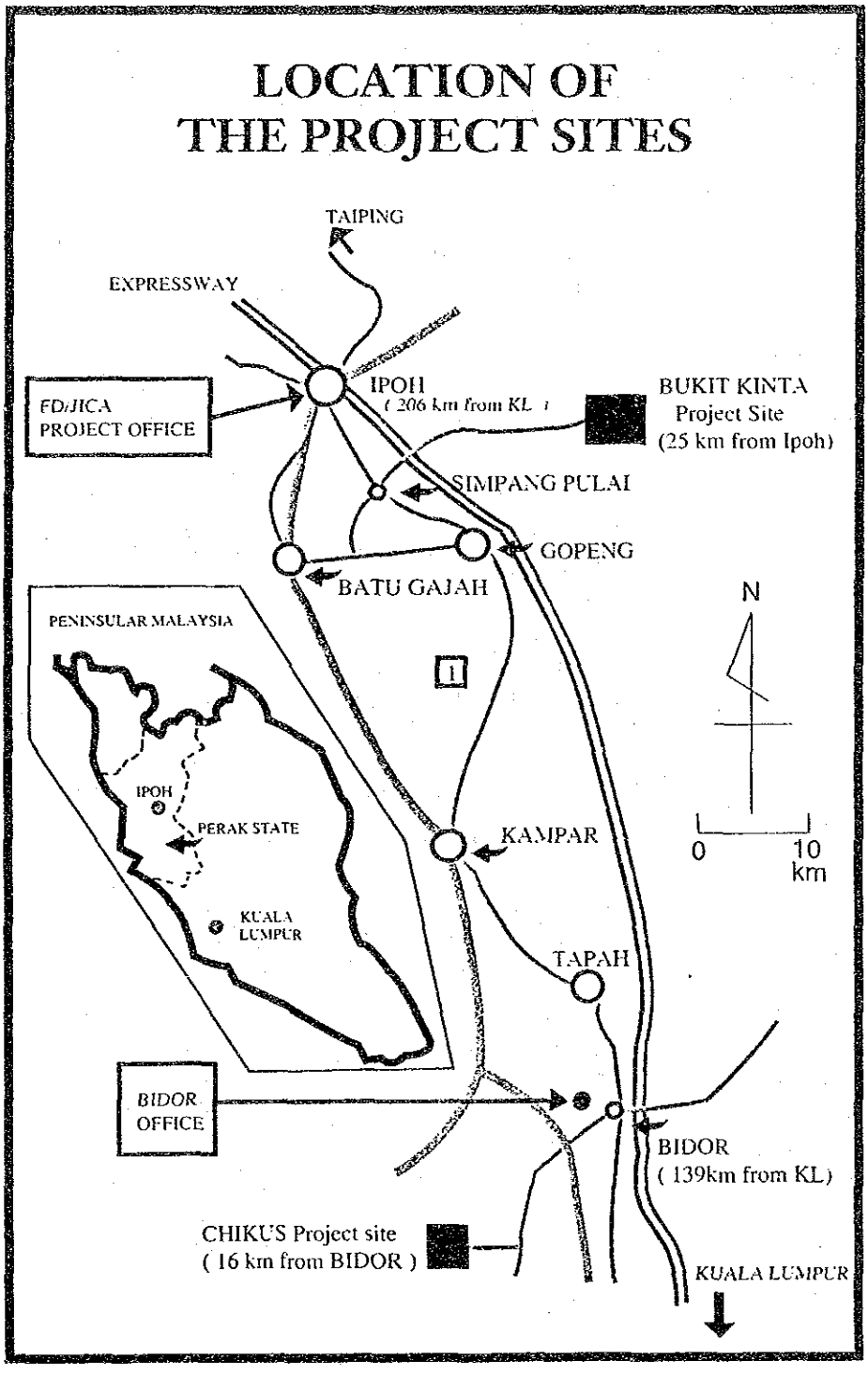
2 The State Of Project Management

2-1 Project Sites And Project Content

The two project sites are located in the state of Perak in the western part of the Peninsular Malaysia. One, a natural forest, is approximately 19 km. southeast of Ipoh, the Perak state capital; the other, a man-made forest, is approximately 80 km. to the south (Fig. 1). The natural forest consists of approximately 300 hectares of logged-over forest in compartments 146, 147, 148 and 150 in Bukit Kinta forest reserve, which is under the Kinta and Manjung district forest office, while the man-made forest consists of approximately 200 hectares of *Acacia mangium* and 300 hectares of bare land in Chikus forest reserve.

In 1992, the project began with the construction of a main logging road, a permanent bridge, shelter and demarcation of gap for the experimental site in compartment 146 Bukit Kinta forest reserve for the planting of high quality tree species. In the man-made forest, two permanent plots will be established namely, Block-A (clear felling), where rows of fast-growing species and high quality species will be planted together; and Block-B (planted with *Acacia mangium*), where high quality species will be planted with five different designs: 1-1 (i.e., one row cut, one row preserved), 2-2, 4-4, 8-8, and 16-16 (in rows 3.7 m. apart in which trees are planted 3.0 m. apart). In the demonstrational plot over 20 species of dipterocarps and non-dipterocarps will be planted.

Fig. 1. Location of the Project Site



2-2 Project Implementation

1) Japanese Experts

Six long-term experts were dispatched in two teams on 14 and 21 December, 1991, to take up their respective posts for a scheduled period of two (2) years. However, the team leader and three members extended their terms while the other two members returned to Japan as scheduled and replaced with the new experts as shown in Table 1. In addition, due to increase in the volume of work in the field of silviculture, the number of experts were increased to two , i.e. Silviculture I and Silviculture II as from 14 December, 1993.

Table 1. Japanese long-term experts

Field	Name	Period of assignment
Team leader	Susumu Sakamoto	14/12/91 - 13/6/94
Work coordinator	Yoshio Abe	14/12/91 - 13/12/95
Silviculture I	Masayuki Iwasa	21/12/91 - 20/12/94
Silviculture II	Hideaki Takai	14/12/93 - 13/12/95
Nursery	Toshimasa Hirasawa	14/12/91 - 13/12/94
Forest management	1. Masaaki Yamada	21/12/91 - 20/12/93
	2. Mutsumi Sakoda	14/12/93 - 13/12/95
Forest machinery	Kikuji Konta	14/12/91 - 13/12/93

Beside the long-term experts, short-term experts were also dispatched to study specific fields during the period. The field of studies carried out by the short-term experts were as shown in Table 2.

Table 2. Japanese short-term experts

Field	Name	Period of assignment
Construction supervision	Toshio Saito	27/5/92 - 25/6, 17/8 - 15/9, 6/12 -20/12
Forest management	Kenzo Tajima	16/11/92 - 15/12
Vegetation	Yukihito Ochiai	25/1/93 - 27/2, 28/6 - 26/7
Soil	Shuhei Aizawa	25/1/93 - 27/2, 26/9 - 25/11
Nursery	Hirota Yamate	25/1/93 - 25/3
Pests and diseases	Takehiro Yamaguchi	26/10/93 - 25/11
Forest management	Ryoji Hayashi	10/1/94 - 28/2
Forest road design	Toshio Saito	25/12/91 - 22/2/92
Building design	Yotaro Hirose	25/12/91 - 8/2/82

2) Counterparts Officers

In line with the Record of Discussions, six (6) officers of Perak State Forestry Department were assigned as counterparts to the Japanese experts. The details of the counterparts are as shown in Table 3.

Table 3. Malaysian counterparts

Field	Name	Period of assignment
Project manager	Dato' Ismail Awang	12/91 - 10/92
	Thai See Kiam*	11/92 - 3/93
	Haji Abdul Rashid b. Mat Amin	4/93 - present
Coordinator	Azahar b. Muda	12/91 - 5/92
	Thai See Kiam	5/92 - 10/93
	Wan Yusoff b. Wan Ahmad	11/93 - present
Silviculture	Roslan b. Ariffin	12/91 - 10/93
	Haji Samsudin b. Salleh	11/93 - present
Nursery	Mangsor b. Mohd. Yusof	12/91 - present
Forest management	Abdul Hadi b. Haji Husin	12/91 - 12/92
	Gan Boon Keong	12/92 - 11/94
Forest machinery	Ir. Lim Kim Heng	12/91 - 6/92
	Mohd. Hassan b. Harun	6/92 - present

* Acting

To facilitate the smooth implementation of the project, the Director of Forest Management in the Forest Department Headquarters will assist in liaison with the higher authorities with regard to allocation of Government of Malaysia financial contribution and approval of assignment of the Japanese experts. District Forest Officers, in which the study area is located, are involved in assisting the counterpart officers in the execution of the project.

2-3 Visits of the Advisory Teams

1) Visit of the First Advisory Team
(January 1993, Team leader: Shiro Kinouchi, Number of team members: 4)
The team was dispatched to monitor the progress since its implementation and suggest measures to be taken for smooth project implementation. During the stay the team also attended the opening ceremony for the Bidor project office and the Second Joint Committee Meeting.

2) Visit of the Second Advisory Team
(November 1993, Team leader: Misao Ishijima, Number of team members: 4)
The team was dispatched with the same objectives as the first visit and visited sites in Bidor, Chikus and Bukit Kinta. The team also suggested on drafting of interim report, and also attended the Third Joint Committee Meeting.

2-4 Joint Committee Meetings

1) The First Joint Committee Meeting
Date/time: April 30, 1992 / 9:30 -12:30
Place: Conference room, Perak State Government Office, Ipoh
The meeting was chaired by Director-General of Forestry Department, Peninsular Malaysia and attended by representatives from EPU Kuala Lumpur, Ministry of Primary Industries, FRIM, Perak state EPU, project manager and all counterparts, team leader and all Japanese experts, representatives from JICA Malaysia office and the Embassy of Japan as well as related staff from the Forestry Department, Peninsular Malaysia and Perak State Forestry Department.

Agenda:
① Presentation of project proposal
② Implementation schedule for the first year including selection of species and seedlings procurement
③ Budget for 1992 (JICA contribution)
④ Proposed budget for 1993 (Malaysian Government contribution)
⑤ Other matters

2) The Second Joint Committee Meeting
Date/time: January 18, 1993 / 10:30 - 12:30
Place: Conference room, FD/JICA project office, Bidor
The meeting was chaired by Director-General of Forestry Department, Peninsular Malaysia and attended by representatives from EPU Kuala Lumpur, Ministry of Primary Industries, FRIM, Perak state EPU, project manager and all counterparts, team leader and all Japanese experts, representatives from JICA Malaysia office as well as related staff from the Forestry Department, Peninsular Malaysia and Perak State Forestry Department.

Agenda:
① Presentation of the 1992 project progress report and the annual plan for 1993
② Malaysian Government contribution for 1993
③ JICA's contribution for 1993
④ Training of Malaysian counterparts for 1993
⑤ Other matters

3) The Third Joint Committee Meeting
Date/time: November 4, 1993 / 9:30 - 12:30
Place: Meeting room, Forestry Department Headquaters, Peninsular Malaysia, Kuala Lumpur
The meeting was chaired by Director-General of Forestry Department, Peninsular Malaysia and attended by representatives from EPU Kuala Lumpur, Ministry of Primary Industries, FRIM, Perak state EPU, project manager and all counterparts, team leader and all Japanese experts, Director and responsible staff of the JICA Malaysia office, representatives from Embassy of Japan as well as related staff from the Forestry Department, Peninsular Malaysia and Perak State Forestry Department.

Agenda:

① Presentation of the 1993 project progress report and the annual plan for 1994
② Malaysian Government contribution for 1994
③ Proposed increase in the total number of Japanese experts
④ 1993 Green Earth Mission
⑤ Other matters

2-5 Working Committee Meeting

This committee, comprised of all experts and counterparts and chaired by the project manager, was founded with the objective of examining and discussing, whenever necessary, the various problems and issues faced in this project and to make the necessary preparations for Joint-Committee Meeting. This committee has met seven times since January 1992.

2-6 Technical Support Committee In Japan

This committee was formed to facilitate technical support for this project from the Japanese side, and provides appropriate advice as needed for technical issues encountered in the project. The Committee members are listed below.

Chairman	Yoshihiko Sasaki	Professor of silviculture, Faculty of Agriculture, University of Tokyo
Vice-Chairman	Kazuya Sadachi	Permanent director, Nihon Ringyo Doyukai
Members	Noriyuki Anyoji	Director, International Division, Japan Forest Technical Association
	Seiichi Mishima	Director, International Forestry Cooperation Office, Planning Section, Forestry Agency
	Teruhiko Kawahara	Director, Forestry and Forestry Products Research Institute
	Shobu Sakurai	Director, Chief, Regeneration Process Laboratory, Forestry and Forestry Products Research Institute
	Tsutomu Handa	Director, Cooperative Investigations Department, Japan Overseas Forestry Consultants Association
	Kiyoshi Fujii	Director, Cooperation Department, Nanpo Zorin Co. Ltd.
	Seiji Mori	Part-time employee, Forestry Policy Research Institute

II Detailed Description

1 Project Conditions

1-1 Natural Conditions

1) Locations And Land Area

Malaysia is a tropical country located north of the Equator within the latitudes 1° to 7° North and longitudes 100° and 119° East. The total land area is approximately 32.9 million ha. with 13.2 million ha. in Peninsular Malaysia, 7.4 million ha. in Sabah and 12.3 million ha. in Sarawak. Peninsular Malaysia which is located between latitudes 1° 20' to 6° 45' North, and extending from longitudes 99° 40' and 104° 20' East is separated from Sabah and Sarawak by 720 km. of the South China Sea, giving the country a coastline of almost 4,830 km.

Peninsular Malaysia is characterized topographically by a series of mountain ranges which dominate the northern and central portion of the country. The main mountain range, which extends from Thailand in the north, to the state of Negri Sembilan in the south, contains a number of peaks having heights of between 1,829 m. and 2,171 m. It is drained by three major river systems. Two of these, the Sungai Kelanatan, and the Sungai Pahang, drain eastwards into the South China Sea while the only major river draining into the Straits of Malacca, in the west, is the Sungai Perak.

2) Climate

The climate of Peninsular Malaysia is typically humid tropical or wet equatorial and is characterized by year round high temperatures and seasonal heavy rain, especially during the North-East Monsoon between November and January. The mean temperatures during the day and night are 32° C and 22° C respectively. The average rainfall is about 2,540 mm. per annum with a maximum of 5,080 mm. and a minimum of 1,650 mm. Humidity is always high and ranges from 70% to 98% and the sky is cloudy most of the day, especially during the monsoon months.

3) Geological Characteristics/Soil

Layers from the latter half of the Cambrian period to the latter half of the Triassic period is uninterrupted. There are little formations from the early Tertiary period, but many from the latter Tertiary period. There is also much Quaternary sedimentation, which contains valuable tin and other minerals. Much of the early Paleozoic rock is metamorphic, while little Triassic rock is non-metamorphic. In Peninsular Malaysia superior forest land can be found along Paleozoic metamorphic rock areas and fault areas. The Chikus area, the site of the man-made forest, has an overall elevation of 10 to 30 metres, with little undulation, and geographically can be divided into two areas: the northeast (where Block-A is located), which has somewhat extensive undulation, relatively deep dales, and a relative difference between dales and forest slope ends of roughly 5 metres; and the southwest (where Block-B is located), which has little undulation, marshes around the dales, and a relative difference between dales and forest slopes of 0.5 to 1 metre. Geologically, the northeast consists of sedimentary and metamorphic rock from the Silurian to Devonian periods, while the southwest is comprised of unconsolidated sediment from the Tertiary period. The Bukit Kinta site is situated on a steep mountain 300 to 600 metres in elevation and consisting of steep dales and ridges. Geologically, it consists of granite, with some distinct exposed rocks in

some dales and other areas, although overall weathering is extensive, with considerable clay formation. Some quartz dikes also exist.

4) Forest Types

The forests of Peninsular Malaysia can be divided into the following seven forest types according to species and elevation.

①	*Montane ericaceous* forest	Elevation: over 1,500 metres
②	*Montane oak* forest	1,200 -- 1,500 metres
③	Upper dipterocarp forest	750 -- 1,200 metres
④	Hill dipterocarp forest	300 -- 750 metres
⑤	Lowland dipterocarp forest	0 -- 300 metres
⑥	Peat & fresh water swamp forest	0 -- 15 metres
⑦	Mangrove forest	

The tropical rain forest of Peninsular Malaysia is one of the most complex ecosystems in the world. It is a unique natural heritage which has evolved over million of years, and is rich and varied in plant and animal life, There are over 8,000 species of flowering plants, of which 2,500 are tree species; well over 200 species of mammals; 600 species of birds; 140 species of snakes; 80 species of lizards and more than 26,000 species of insects.

It has been estimated that 890 of the 2,500 tree species reach harvestable sizes of at least 45 cm. diameter at breast height (dbh). Of theses 890 species, a total of 408 have been introduced at one time or another to the international markets under the Malaysian Grading Rules.

The Bukit Kinta site of the project is a logged-over hill dipterocarp forest. The Chikus site is formerly a poor lowland dipterocarp forest which was cleared for the establishment of forest plantation. Majority of this area has been planted with *Acacia mangium* since 1988.

1-2 Socio-Economic Conditions in Peninsular Malaysia

1) Population

Based on 1980 census, the population of Peninsular Malaysia is 11.427 million and estimated to be 14.303 million in 1989. Based on population growth studies in 1980, the population will increase to 70 million by the year 2020.

2) Economic Structure And Trend

Traditionally the Malaysian economy is dependent on the export of primary products, such as petroleum, rubber, tin and sawn timber. A world-wide stagnation in the price of these products during the 1980s led to decrease in export revenue. However, since the late 1980s, increase in prices of these products has significantly increased exports revenue, supporting an economic recovery with a rate of economic growth of 8 percent since 1990.

3) Labor And Employment

Malaysia experiences high unemployment rate during the 1980s. Agriculture, forestry and fisheries accounted for 30% of the workforce in 1990, making them the country's largest source of employment, but this percentage has been decreasing as new jobs in the service and manufacturing industries expanded rapidly.

Most of the plantation workers have migrated to the cities in search of better working conditions, forcing local plantation owners to hire foreign workers (e.g., from Indonesia, Thailand, and Bangladesh). As a result, the forestry sector also experiences serious labour shortages.

1-3 Forestry Administration And Policy

Under the Malaysia constitution, rights concerning land are entrusted to state governments, which can pass their own laws and policies on forestry; the role of the federal government (i.e., Federal Forestry Department) is in the field of advice on policy and technical matters. The National Forestry Policy, designed to strengthen cooperative relations between the federal and state governments and promote unified forestry policy, was approved by the National Land Council on the 10th. April, 1978 and concerns the following.

1) To dedicate as Permanent Forest Estate sufficient areas of land strategically located throughout the country, in accordance with the concept of rational land use, in order to ensure:-

i) the sound climatic and physical condition of the country, the safeguarding of water supplies, soil fertility and environmental quality and the minimization of damage by floods and erosion to rivers and agricultural land; such forest lands being known as:
PROTECTIVE FORESTS;

ii) the supply in perpetuity, at reasonable rates of all forms of forest produce which can be economically produced within the country and are required for agricultural, domestic and industrial purposes, and for export; such forest land being known as:
PRODUCTIVE FORESTS;

iii) the conservation of adequate forest areas for recreation, education, research and the protection of the country's unique flora and fauna; such forest lands being known as:
AMENITY FORESTS.

2) To manage the Permanent Forest Estate with the object of maximising social, economic and environmental benefits for the Nation and its people in accordance with the principles of sound forest management.

3) To pursue a sound programme of forest development through regeneration and rehabilitation operations in accordance with approved silvicultural practices in order to achieve maximum productivity from the Permanent Forest Estate.

4) To ensure thorough and efficient utilisation of forest resources on land not included in the Permanent Forest Estate, prior to the alienation of such land, by means of proper coordinated planning by land development agencies in order to obtain maximum benefits for the people through complete harvesting and processing of such resources, adhering strictly to the optimum need of local processing industries.

5) To promote efficient harvesting and utilization of all forms of forest produce and to stimulate the development of appropriate wood-based industries with determined capacities commensurate with the resource flow in order to achieve maximum resource utilization, create employment opportunities and earn foreign exchange.

6) To ensure the sound development of trade and commerce in and to promote the exportation of forest products.

7) To promote effective Bumiputra participation in forest and wood-based industries consistent with Government policy.

8) To undertake and support an intensive research programme in forest development aimed at achieving maximum yield from the Permanent Forest Estate, maximum direct and indirect benefits from harvesting and utilization and, above all maximum financial return on investment in forest development activities.

9) To undertake and support a comprehensive programme of forestry training at all levels in the public sector in order to ensure an adequate supply of trained manpower to meet the requirements of forestry and wood-based industries.

10) To encourage private sector's involvement in forestry research and training at all levels with a view to accelerate industrial development and enhance the quality of professionalism in forestry and forest industrial practices.

11) To foster, by education and publicity, a better understanding among the community of the multiple values of forests to them and their descendants.

12) To foster close cooperation among all in order to achieve optimum utilization of the valuable natural resources of the country.

1-4 Forestry In Perak

1) History

The Forestry Department of Perak established in 1901 by the British. The first Deputy Conservator was sent to Perak in the same year and District Forest Offices were established in the following year. Gunung Semanggol Forest Reserve became the first Forest Reserve to be gazetted on October 12, 1900.

2) Location

The state of Perak is located in north eastern Peninsular Malaysia, between northern latitudes 4° 50' and 5° 45', and between eastern longitudes 100° 50' and 101° 50'. It is adjacent to Penang and Kedah to the west, Pahang and Kelantan to the east, Selangor to the south, and Thailand to the north.

3) Climate

The climate is equatorial with much rain and humidity, characterized by two rainy seasons (from March to May and October to November or December), between which are two dry seasons, with relatively little precipitation. The average rainfall is about 2,700 mm. per annum with a maximum of 3,810 mm. and a minimum of 1,590 mm.

4) Flora

The terrain of Perak is characterized by gentle slopes between the western coast and the eastern mountains along the state border, encompassing seven forest types, from the mangrove forests along the coast to *Montane ericaceous*, growing at an elevation of 2,183 metres. This diversity includes not only an abundance of forest resources, but also many types of plants and animals. The natural forests in Malaysia contain about 8,000 species of flowering plants, of which 2,500 are trees. Also living here are over 200 species of mammals, 600 species of birds, 140 species of snakes, 80 species of lizards, and thousands of species of insects.

5) Forest Resources

The total land area of Perak, including marine regions and developed areas, is approximately 21,025 square kilometres. Of this, permanent forests account for 996,000 hectares, or 47.4% of the total land area. A total of 3,281 hectares is man-made forest, the remaining being natural forest.

6) Forest Administration

The State Forestry Department has five District Forest Offices, the jurisdiction of which are divided according to topography, rivers and other natural features. Each District Forest Officer will have either one or two deputies together with uniform staff comprising of rangers, foresters and forest workers.

7) Forest Plantation

The State government of Perak has spent about RM 3.6 million to establish 1,600 hectares of man-made forest in the Chikus region between 1988 and 1989, to implement the first stage of the Forest Compensatory Plantation Project. An additional RM 5.4 million was required to finance phase two of the project, scheduled for a five-year period between 1990 and 1994 on 4,000 hectares of land in Gunung Besout. The main species planted is *Acacia mangium*, of which a harvest of 180 $m.^3$ per hectare over a 15-year period is expected. This species is said to have a strength and applicability equivalent to light red meranti and can be used as general utility timber.

8) Enrichment Planting

Due to the fluctuation of flowering and fruiting period of commercial species and the short life span of seeds under an enclosed canopy, the natural regeneration of commercial species, particularly dipterocarps, is not good. Hence, under the former Malayan Uniform System of forest management, which emphasizes natural regeneration, improved methods of regeneration are often needed. Based on the results of pre-felling inventory and post-felling inventory, the management will determine the types of treatments required for the area. If the treatment required is enrichment planting, wildings will be collected from natural forests and raised for 3 to 4 months in the nursery. Enrichment planting, introduced in Perak in 1968, has been concentrated in South Perak, Kinta Manjung and Kuala Kangsar District Forest Offices. Records show that 4,447 hectares have been planted, all in easily accessible lowlands and hilly areas. The main species planted are the *Shorea* and *Dipterocarp* families, as well as *Agathis bornensis*, *Anisoptera* spp., and *Scaphium* spp., etc. Species are selected on the basis of suitability with local conditions.

9) Forest Recreational Areas

The Forestry Department began promoting their Forest Recreational Areas in earnest between 1981 and 1985 under the Fourth Malaysian Plan, and today there are 11 forest recreational parks in Perak. Visitors to forest recreational parks have been increasing at a rate of 20% each year, and in 1992, visitors to all forest recreational parks in Perak numbered at 155,171. Kuala Woh Recreational Park, the most popular park, is located 13 kilometres from Tapah off the road leading to Cameron Highlands. As of late 1992, a total of RM 6 million (including facility costs) have been spent on the 11 forest recreational parks in Perak.

10) Forest Management Systems

The first recorded forest management of importance in Peninsular Malaysia is generally known as the 'gutta percha' era (1900-1910). For the period 1910-1922 a series of silvicultural treatments known as Departmental Improvement Fellings was implemented. After 1922, a change occured in the exploitation of the forests as Forest Reserves were opened for logging mainly for firewood while the mining boom had also created a strong demand for poles.

After the Pacific War, it was observed that many of the untended clear-fellings made during the war contained adequate advanced seedlings regeneration. These factors led to the formulation of the Malayan Uniform System (MUS) in 1948. This MUS has been successfully applied to the lowland dipterocarp forest but has been found to be unsuccessful in the hill dipterocarp forest. The reasons for that include the more difficult terrain, uneven sotcking, lack of natural regeneration on the forest floor before logging and irregular seeding from potential mother trees.

Consequently, in recent years, the Selective Management System (SMS) was evolved and offer the following advantages:-

- the flexibility to manage the highly variable forest conditions and the changes in socio-economic environment
- it will allow for the optimization of forest management goals, i.e. an economic cut, the sustainability of the forest and the minimum cost for forest development

11) Silvicultural Work

Generally, silvicultural works are carried out to rehabilitate forest areas that have been logged. Although encompassing thinning and clean-cutting until the 1970s, today silvicultural techniques are limited to vine-cutting and girdling.

12) Wood-Based Industry

The wood-based industry in Perak began growing rapidly in the 1950s along with the introduction of the steam-operated band saw in sawmills. At present 95 sawmills had been licensed in Perak. These sawmills utilise 65% of logs produced locally. Another 25% is utilised by the plywood/veneer mills. The remaining 10% is accounted for by blockboard and pallet fabrication. Perak is also rich in rubber wood resources: roughly 5,000 of the 237,991 hectares of rubbers trees are replanted annually, with approximately 240,000 $m.^3$ of rubber wood produced (according to the state forestry plan for the period of 1986-1995).

13) Mangrove Forest

The state of Perak contains a total of 43,502 hectares of mangrove forests, the largest share of which (40,711 hectares) is in the Larut Matang region (under jurisdiction of the Taiping district forest office). This forest is divided into 19 forest reserves and 108 compartments. A total of 95% of this forest area is subject to the effects of tidal changes, and classified into five categories (using Watson Inundation class). Total area of 84% is timber-producing and 16% is protected. In Matang, where all forests have been managed and conserved under 10-year Mangrove Working Plan since 1908, active research on artificial regeneration techniques is being carried out. Mangrove timber produced in this area (90% of which is used in charcoal production and 10% as piling) plays a major role in the local economy.

1-5 Land Utilization

1) Land Utilization

Land utilization in the western coastal section of Peninsular Malaysia is characterized by tin mining and agriculture plantation. Tin mining, centered around the Kinta area of Perak (throughout eastern Ipoh), first became prominent around the 15th. century, but was greatly accelerated by the discovery of a major vein in 1880. According to figures based on aerial photographs taken in 1984, the land area of tin mining and the state of abandoned tin mines in each state of the Peninsular Malaysia are as follows.

The land area of tin mining and state of abandoned tin mines (ha.)

State	The surface area of mines	Farmland	Non-farmland	Unutilized wasteland
Perlis	(800)*	-	-	(800)*
Kedah	2,510	10	20	2,480
Penang	10	-	-	10
Perak	71,850	3,890	2,300	65,660
Selangor/KL	28,250	830	3,920	23,500
N. Sembilan	2,090	-	-	2,090
Melaka	380	-	-	380
Johor	5,660	-	-	5,660
Pahang	2,910	-	-	2,910
Terengganu	40	-	-	40
Kelantan	-	-	-	-
Total	113,700 (100%)	4,730 (4.2%)	6,240 (5.5%)	102,730 (90.3%)

** denotes underground mining*

As shown above, less than 10% of abandoned tin mines are currently being utilized, with the remaining 90% idle. These abandoned tin mines, having developed the appropriate technology, could be rehalitated into forest areas.

Rubber tree planting grew rapidly in the late 1800s, and large rubber tree plantations were being established in the early 1900s. Today they account for approximately 1.9 million hectares of land.

Although palm oil growing has a relatively short history, the number of hectares under cultivation has increased rapidly since the 1960s and today slightly exceeds that of rubber plantations.

Malaysia's basic National Agricultural Policy, since gaining independence in 1957, has been to promote intensive agriculture, encouraging of double-cropping, the development of new farmland, and the establishment of government-funded organizations like the Federal Land Development Authority (FELDA).

In the field of agriculture, the number of hectares of farmland under intensive cultivation has increased rapidly, while the hectares of rubber, oil palm, cocoa and other trees replanted each year continues to grow, albeit in recent years at a slightly slower pace.

Land in Peninsular Malaysia is divided into the following five classes according to its utilization.

Class 1: Land possessing a high potential for possible mineral development.
Class 2: Land possessing a high potential for possible agricultural development with a wide range of crops.
Class 3: Land possessing a moderate potential for possible agricultural development with a restricted range of crops.
Class 4: Land possessing a high potential for productive forest development.
Class 5: Land possessing little or no mineral, agricultural or productive forest potential but suitable for possible development as protective forest, water catchment areas, game reserves, national parks, etc.

As these categories show, highest priority in land utilization is given to the development of mineral resources, with productive farmland and forestry follow accordingly.

Currently, under the New Economic Policy and Vision 2020 of the Malaysian Government, Malaysia is going towards utilizing local natural resources in enhancing and accelerating the development of an industrialized nation.

1-6 Significance of Multi-Storied Forest Management Project

Malaysia's policy of fostering and strengthening ties with the private sector is the factor behind the inception of this project. Both Malaysia and Japan shared this view, especially the importance of private sector investment in large-scale afforestation. The results from this Multi-Storied Forest Management Project can be translated into usage in both man-made forests and natural forests.

In spite of the failure to implement budgetary measures for the project in the first fiscal year due to problems with domestic legalities, Malaysia's budgetary measures have been enhanced each year thereafter.

2 Project Facilities and Equipment

2-1 Infrastructure Improvement

Infrastructure improvement in this project involved construction by the Japanese side of facilities and forest roads at the two sites (in the forest reserves of Bukit Kinta and Chikus) and a project office in Bidor. Short-term experts were dispatched from Japan for all related design work and to supervise construction, with actual construction carried-out by local contractors. The nursery in Chikus and the project office in Bidor were subsequently expanded and improved. Below is an overview of the various facilities.

1) Nursery

(1) Infrastructure Improvement

① Period of construction: June 12 - December 16, 1992

② Description: 58 seedbeds and beds shading, ground preparation for nurseries, piping and other irrigation equipment, water intake equipment, water tower, water tanks, pumps, watching tower, etc.

③ Contractor: Syarikat Pemborong Abu Bakar

④ Total construction costs: RM 305,676.00

a.	Nursery site preparation and development	RM 12,000.00
b.	Seedbeds and beds shading	RM 47,280.00
c.	Irrigation and intake equipment	RM 82,300.00
d.	Piping and water tower, etc.	RM 41,000.00
e.	Watching tower	RM 17,000.00
f.	Gates and fence	RM 17,000.00
g.	Septic tank, drainage for premises, etc.	RM106,096.00

(2) Supplemental Work For Nurseries

① Period of construction: November 18, 1992 - February 9, 1993

② Description: Outdoor toilets for nurseries, seedbed gravel, expansion of generator room, sewerage work

③ Contractor: Bina Taiping Sdn. Bhd.

④ Total construction costs: RM 20,100.00

a.	Outdoor toilet	RM 9,600.00
b.	Seedbed gravel	RM 6,000.00
c.	Expansion of generator room	RM 4,000.00
d.	Sewerage work	RM 500.00

(3) Supplemental Work For Irrigation And Drainage Equipment

① Period of construction: January 15 - March 31, 1993

② Description: Irrigation sprinklers, drainage for nursery beds

③ Contractor: Bina Taiping Sdn. Bhd.

④ Total construction costs: RM 24,800.00

a.	Irrigation sprinklers	RM 22,000.00
b.	Drainage for nursery beds	RM 2,800.00

(4) Supplemental Work On Seedbeds And Beds Shadings

① Period of construction: January 22 - March 22,1993

② Description: 52 seedbeds and beds shading, turfing and gravelling

③ Contractor: Bina Taiping Sdn. Bhd.

④ Total construction costs: RM 72,657.00

a.	Seedbeds and beds shading	RM 50,352.00
b.	Turfing	RM 8,765.00
c.	Gravelling	RM 13,540.00

(5) Nursery Ditches

① Period of construction December 5, 1993 - January 21, 1994

② Description: Construction of one cross-nursery ditch for upper and lower nurseries

③ Contractor: Baharuddin B. Ismail

④ Total construction costs: RM 11,000.00

2) Forest Roads

2)-1 Chikus

(1) Main Forest Road (1992: 8,050 m. Extension)

① Period of construction: June 12 - December 16, 1992

② Contractor: Syarikat Pemborong Abu Bakar

③ Total construction costs: RM 135,305.00

(2) Fire Break (10,851.50 m. Extension)

① Period of construction: June 12 - December 16, 1992

② Contractor: Syarikat Pemborong Abu Bakar

③ Total construction cots: RM 89,530.00

2)-2 Bukit Kinta

(1) Main Forest Road (1992: 1,660 m. Extension)

① Period of construction: June 12 -- December 16, 1992

② Contractor: Syarikat Pemborong Abu Bakar

③ Total construction costs: RM 135,640.00

3) Building

3)-1 Bidor

(1) Bidor Office

① Period of construction: June 12 - December 16, 1992

② Description: Two-storey ferro-concrete office (616 m.^{2}) with aluminium slate roofing and garage

③ Contractor: Syarikat Pemborong Abu Bakar

④ Total construction costs: RM 554,000.00

a.	Office	RM492,800.00
b.	Garage	RM 61,200.00

(2) Car Porch And Garage

① Period of construction: February 27 - March 22, 1993

② Description: Car porch of Bidor office and garage

③ Contractor: Bina Taiping Sdn. Bhd.

④ Total construction costs: RM 23,300.00

a.	Car porch	RM 12,000.00
b.	Two garages	RM 11,300.00

3)-2 Chikus

(1) Infrastructure Improvement

① Period of construction: June 12 - December 16, 1992

② Description: Nursery office, garage, smoking room, operation room, warehouse, germination room, glass house, compost shed, generator room, oil storage house, car washing area

③ Contractor: Syarikat Pemborong Abu Bakar

④ Total construction costs: RM 250,700.00

a.	Nursery office	85 m.^{2}	RM 42,900.00
b.	Garage	126 m.^{2}	RM 56,700.00
c.	Smoking room	6 m.^{2}	RM 2,400.00
d.	Operation room	128 m.^{2}	RM 51,200.00
e.	Warehouse	30 m.^{2}	RM 12,000.00
f.	Germination room	30 m.^{2}	RM 12,000.00
g.	Glass house	30 m.^{2}	RM 25,500.00
h.	Compost shed	84 m.^{2}	RM 33,600.00
i.	Generator room	10 m.^{2}	RM 4,000.00
j.	Oil storage house	12 m.^{2}	RM 5,400.00
k.	Car washing area		RM 5,000.00

(2) Construction Of Security Booth

① Period of construction: September 1 - October 13, 1993

② Description: Security booth, fence and gate

③ Contractor: Bina Taiping Sdn. Bhd.

④ Total construction costs: RM 6,620.00

a.	Security booth	RM	3,400.00
b.	Fence	RM	1,620.00
c.	Gate	RM	1,600.00

(3) Construction Of Incinerator Generator Room

① Period of construction: October 15 - November 10, 1993

② Description: Construction of incinerator generator room (24.10 $m.^2$)

③ Contractor: Bina Taiping Sdn. Bhd.

④ Total construction costs: RM 8,630.00

3)-3 Bukit Kinta

(1) Infrastructure Improvement

① Period of construction: June 12 - December 16, 1992

② Description: Emergency shelter (prefabricated)

③ Contractor: Syarikat Pemborong Abu Bakar

④ Total construction costs: RM 38,000.00

2-2 Procurement Of Equipment

1) Current Circumstances

While nearly all equipment needed in this project were procurable in Malaysia, special devices (e.g., office equipment, observation instruments, optical devices, measuring equipment and surveying equipment) were procured in Japan. Large-sized four-wheel-drive trucks, which were not sold by local dealers, were shipped in from Japan, while all other vehicles have been purchased locally. Nursery soil sifters, seedling box roller conveyers, water trucks and other simple equipment were ordered specially from local dealers.

Genuine parts for locally procured vehicles, construction equipment, agricultural and forestry equipment and power equipment could be ordered from the manufacturer through local outlets, while parts for equipment from Japan (e.g., office equipment) were sent from Japan.

2) Issues

Because specialized technical knowledge was needed to install and operate some models of optical and measuring equipment, observation instruments and surveying equipment procured in Japan, models were selected after verifying the existence of local dealers. Also, it was necessary to take into consideration counterparts' needs when procuring personal computers, printers and other devices, and to select compatible models.

3) Equipment Control

Equipment procured locally and equipment shipped-in from Japan are categorized as fixed assets and non-fixed assets each according to its value and kept track with separate logs. As of late February 1994, fixed assets stand at RM 1,465,234.60 (the local currency), or ¥ 31,084,598.00; non-fixed assets at RM 254,955.44 (¥ 7,549,070.00).

See Tables 1 and 2 for a breakdown of fixed assets and non-fixed assets.

Table 1. Major category: fixed assets

Immediate category	Sub-category		Immediate category	Sub-category	
Mechanical	Construction equipment	RM 533,790.00	Tools, etc.	Various devices	RM 49,127.75
devices	Agriculture & forestry			Tools	0
	equipment	RM 105,500.00		Audiovisual equipment	RM 4,500.00
	Power equipment	RM 76,500.00		Office equipment	RM 32,600.00
Vehicles	Firefighting equipment	RM 66,144.57			¥ 2,917,600.00
	Automobiles	RM 535,857.28		Instruments	RM 44,500.00
		¥ 14,200,000.00			¥ 13,449,998.00
Various	Sanitation equipment	0		Optical and measuring	RM 12,215.00
appliances	Furniture	0		equipment	¥ 130,000.00
	Office furniture	RM 4,500.00		Surveying equipment	¥ 387,000.00
	Miscellaneous	0	Documents	Equipment manuals	0

* The above encompasses non-consumables with a purchase (unit) price of at least ¥ 200,000 or RM 4,000.00.
* RM: Malaysian currency
* ¥: Japanese yen

Table 2: Major category: non-fixed assets

Immediate category	Sub-category		Immediate category	Sub-category	
Tools, etc.	Tools	RM 21,613.00	Tools, etc.	Audiovisual equipment	RM 13,685.00
	Office equipment	RM 14,720.00		Observation instruments	¥ 2,136,200.00
		¥ 997,000.00	Various	Agricultural equipment	RM 23,550.00
	Various devices	RM 103,455.84	appliances	Stationery	RM 892.00
		¥ 1,304,100.00			¥ 27,960.00
	Surveying equipment	RM 1,300.00		Office furniture	RM 50,301.00
		¥ 1,570,950.00		Library	RM 750.00
	Optical and measuring	RM 5,279.50		Furniture	RM 8,786.00
	equipment	¥ 826,860.00		Miscellaneous	RM 5,889.00
	Firefighting equipment	¥ 646,000.00			¥ 40,000.00
	Audio equipment and	RM 152.00	Documents	Documents	RM 3,782.60
	clocks, etc.				
	Lighting	RM 800.00			

* The above encompasses non-consumables with a purchase (unit) price of at least ¥ 200,000 or RM 4,000.00.
* RM: Malaysian currency
* ¥: Japanese yen

2-3 Equipment Installation And Maintenance

1) The State Of Equipment Installation (See Table 3)

According to Table 3 nearly all equipment have been installed as planned, the bulldozer and backhoe included in the original plan were substituted with a motor grader and small-sized roadwork machinery in response to a proposal from the Malaysian side at the 1st. working committee.

Also, the cargo truck for the Bukit Kinta site was changed to a general-purpose dump truck in order to complement the construction work of forest road by motor grader.

The weather observation equipment is not yet in operation.

This is because it was decided to use solar batteries (instead of the generators originally planned) to power the weather observation equipment due to the facilities of 24-hour automatic observation in mountainous and other areas.

Table 3. Plan and the state of equipment installation (1)

Installation plan		Installation result	
Type of equipment	**Quantity**	**Type of equipment**	**Quantity**
Ipoh office			
Passenger/freight vehicle	1	Toyota Landcruiser	2
Micro bus	1	Toyota Liteace	1
Copier	1	Minolta copier (lease)	1
Bidor office			
		Toshiba copier	1
Four-wheel drive truck	5	Mitsubishi Pajero	5
Micro bus	1	Mitsubishi micro bus (capacity: 25)	1
		Yamaha DT-125 motor bike	2
Chikus nursery			
Multipurpose loader	1	Bobcat	1
Excavator	1		
Cargo truck	1	Isuzu 4WD 4t	1
Farm tractor	1	Ford 4WD-3930	1
Soil sifter	1	Produced locally	1
Soil mixer	1	Produced locally	2
Roller conveyer	1 set	Produced locally	1 set
Power sprayer	2	Kubota 16KVA	2
Generator	1	Incinerator/generator	1 set
Weather observation device	1 set	Ohta measuring equipment DS801	1 set
		Air compressor	1
		Water tank 1,000L	1
Bukit Kinta			
Bulldozer	1	Motor Grader MG330	1
Back hoe	1	John Deer back hoe loader	1
Fork lift	1	Mitsubishi FD25T	1
Cargo truck	2	Mitsubishi dump truck	2
Passenger/freight vehicle	2	Toyota Hilux 4WD	2
Weather observation device	1 set	Ohta measuring equipment DS801	1 set
Forest fire prevention equipment			
Cargo truck	1	Daihatsu Delta V99HB	1

2) Equipment Utilization

Tables 4 and 5 show the utilization of vehicles already delivered.

Table 4. Dates of vehicles registration and start of use

Vehicle	Date of registration	Start of use	Delay	Remarks
Pajero (1)	May 1992	May 1992	0	
Pajero (2)	May 1992	May 1992	0	
Pajero (3)	May 1992	May 1992	0	
Lite Ace	June 1992	July 1992	1	
Landcruiser	June 1992	July 1992	1	
Hilux	June 1992	July 1992	1	
Fork lift	July 1992	March 1993	8	
Bobcat	October 1992	December 1992	2	
Wheel loader	October 1992	March 1993	5	
Tractor	November 1992	November 1992	0	
Station wagon	December 1992	January 1993	1	
Cargo truck (1)	December 1992	March 1993	3	
Motor grader	January 1993	April 1993	3	
Pajero (4)	February 1993	March 1993	1	
Pajero (5)	February 1993	March 1993	1	
Micro bus	June 1993	August 1993	2	
Motor bike (1)	July 1993	July 1993	0	
Motor bike (2)	July 1993	July 1993	0	
Dump truck (1)	November 1993	January 1994	2	
Dump truck (2)	Decemver 1993	February 1994	2	

Note: "**Delay**" indicates the number of months between registration and the start of use.

Table 5 shows that the utilization of equipment for nurseries, logging roads and other special work were relatively low in contrast to the favourable state of use of passenger and freight vehicles.

This is due to (1) the shortage of personnel capable of operating special vehicles, and (2) high rates of subcontracting in actual work.

Hence, we should consider to lease these equipment to contractors as well as increasing the use of them in our project.

Table 5. Changes in vehicles utilization rates

Year			1992											
Month		Date of Registration	5		6		7		8		9		10	
Days Expected to Work	Number		24		23		27		24		26		27	
Days Worked			Work	Rate	Work	Rate	Work	Rate	Work	Rate	Work	Rate	Work	Rate
Pajero	ACC-4156	1992.5.15	2	8.3	17	73.9	18	66.7	21	87.5	19	73.1	13	48.1
Pajero	ACC-4157	5.15	5	20.8	20	87.0	19	70.4	24	100.0	24	92.3	26	96.3
Pajero	ACC-4158	5.15	1	4.2	13	56.5	17	63.0	24	100.0	21	80.8	25	92.6
Lite Ace	ACC-9607	6.29					3	11.1	12	50.0	25	96.2	25	92.6
Landcruser	ACC-9608	6.29					11	40.7	21	87.5	18	69.2	17	63.0
Hilux	ACC-6677	6.29					3	11.1	7	29.2	18	69.2	30	111.1
Fork Lift	ACS-7143	7.13												
Wheel Loader	ACE-1418	10.1												
Bobcat	ACD-2055	10.5												
Tractor	ACE-6470	11.8												
Station Wagon	ACF-1771	12.29												
Cargo Truck	ACF-3827	12.3												
Motor Grader	ACF-5134	1993.1.8												
Pajero	ACG-670	2.16												
Pajero	ACG-698	2.18												
Micro Bus	ACH-2756	6.24												
Motor Bike	ACH-9871	7.7												
Motor Bike	ACH-9913	7.9												
Dump Truck	ACK-7348	11.19												
Dump Truck	ACL-120	12.1												

Year														
Month	11		12		1		2		3		4		5	
Days Expected to Work	24		26		24		23		24		25		24	
Days Worked	Work	Rate	Work	Rate	Work	Rate	Work	Rate	Work	Rate	Work	Rate	Work	Rate
Pajero	20	83.3	18	69.2	14	58.3	14	60.9	21	87.5	8	32.0	3	12.5
Pajero	25	104.2	23	88.5	23	95.8	23	100.0	31	129.2	26	104.0	24	100.0
Pajero	24	100.0	23	88.5	18	75.0	23	100.0	15	62.5	22	88.0	23	95.8
Lite Ace	27	112.5	30	115.4	26	108.3	24	104.3	18	75.0	21	84.0	25	104.2
Landcruser	23	95.8	24	92.3	20	83.3	24	104.3	21	87.5	21	84.0	27	112.5
Hilux	27	112.5	27	103.8	25	104.2	25	108.7	18	75.0	18	72.0	18	75.0
Fork Lift									2	8.3	1	4.0	3	12.5
Wheel Loader			1	3.8	0	0.0	0	0.0	2	8.3	0	0.0	2	8.3
Bobcat									6	25.0	16	64.0	16	66.7
Tractor	3	12.5	6	23.1	4	16.7	5	21.7	7	29.2	5	20.0	4	16.7
Station Wagon					20	83.3	26	113.0	21	87.5	25	100.0	28	116.7
Cargo Truck									2	8.3	0	0.0	0	0.0
Motor Grader											3	12.0	4	16.7
Pajero									12	50.0	22	88.0	24	100.0
Pajero									10	41.7	22	88.0	24	100.0
Micro Bus														
Motor Bike														
Motor Bike														
Dump Truck														
Dump Truck														

Year	1993														Total	
Month	6		7		8		9		10		11		12			
Days Expected to Work	27		24		26		26		25		25		26		501	
Days Worked	Work	Rate	Work	Rate	Work	Rate	Work	Rate	Work	Rate	Work	Rate	Work	Rate	Work	Rate
Pajero	10	37.0	19	79.2	13	50.0	11	42.3	11	42.3		0.0		0.0	252	50.3
Pajero	25	92.6	27	112.5	20	76.9	25	96.2	27	103.8	25	100.0	21	80.8	463	92.4
Pajero	23	85.2	28	116.7	22	84.6	26	100.0	28	107.7	23	92.0		0.0	399	79.6
Lite Ace	23	85.2	26	108.3	17	65.4	15	57.7	25	96.2	19	76.0	20	76.9	361	83.9
Landcruser	22	81.5	24	100.0	21	80.8	26	100.0	18	69.2	24	96.0	18	69.2	380	83.7
Hilux	27	100.0	27	112.5	22	84.6	25	96.2	22	84.6	22	88.0		0.0	361	79.5
Fork Lift	1	3.7	2	8.3	1	3.8	1	3.8		0.0		0.0		0.0	11	4.3
Wheel Loader	1	3.7	1	4.2	1	3.8	1	3.8		0.0		0.0		0.0	9	2.8
Bobcat	9	33.3	2	8.3	0	0.0	13	50.0	15	57.7	12	48.0	16	61.5	105	41.5
Tractor	3	11.1	6	25.0	5	19.2	5	19.2	6	30.8	9	36.0		0.0	70	28.0
Station Wagon	24	88.9	25	104.2	18	69.2	13	50.0	1	3.8	1	4.0	20	76.9	222	74.0
Cargo Truck	0	0.0	5	20.8	17	65.4	23	88.5	12	46.2	13	52.0	20	76.9	92	36.4
Motor Grader	3	11.1	3	12.5	2	7.7	2	7.7	0	0.0	2	8.0	6	23.1	25	10.9
Pajero	20	74.1	29	120.8	27	103.8	25	100.0	30	115.4	28	112.0	27	103.8	245	96.8
Pajero	27	100.0	27	112.5	27	103.8	18	69.2	11	42.3		0.0		0.0	166	65.6
Micro Bus				0.0	1	3.8	15	57.7	26	100.0	25	100.0		0.0	87	51.9
Motor Bike			1	4.2	2	7.7	0	0.0	2	7.7	15	60.0	10	38.5	30	19.5
Motor Bike			4	16.7	1	3.8	1	3.8		0.0		0.0		0.0	6	3.9
Dump Truck																
Dump Truck																

Note: The utilization rate is calculated with the following equation.
Days utilized/scheduled days utilized (the total number of days in the month minus Sundays and holidays)

3) Problems In Vehicles' Registration

As Table 4 shows, the registration of dump trucks was delayed until November and December 1993. This was primarily because of certain requirements in Malaysian vehicle registration system.

Specifically, it was decided to bring from Japan four-wheel-drive dump trucks capable of withstanding the severe road conditions (such as operating on logging roads with a slope of 20 percent or higher).

However, upon applying to Malaysian Road Transport Department for vehicle registration for domestic use, we were told that the registration could not be approved unless the bodies (excluding the engine and chassis) were made in Malaysia and was asked to submit plans drafted by a designer approved by the Malaysian government.

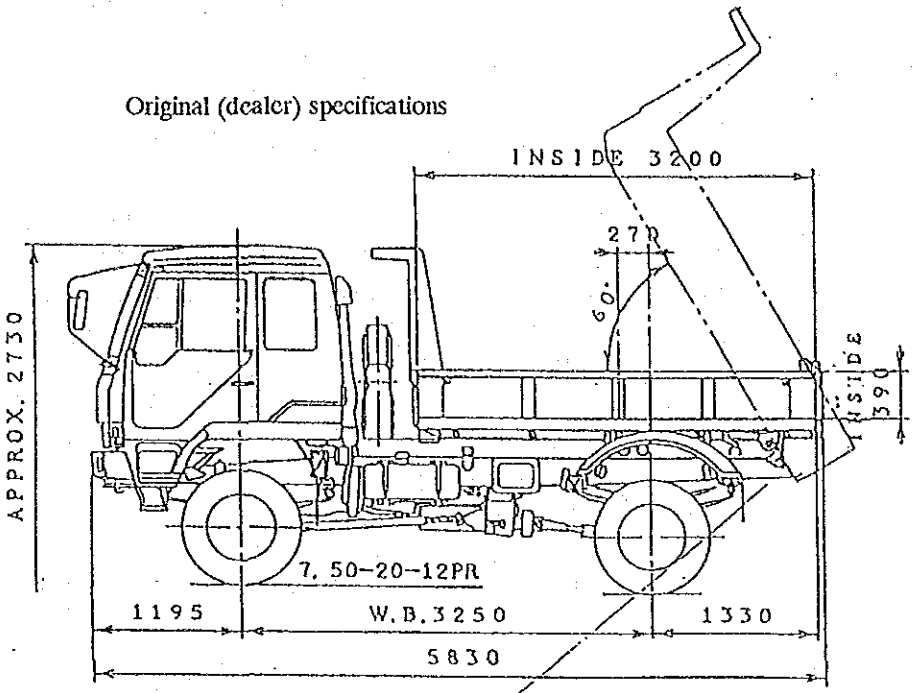
Plan drafting and body construction were then contracted to an engineering firm. The plan was drafted according to specification sheets drafted by the manufacturer for sale in Japan, with the exhaust pipe location and other details changed according to Malaysian specifications. The dump trucks were thus recognized as made in Malaysia and vehicle registration was finally approved.

The entire process took over a year. Plan drafting and specification changes costed nearly RM 6,000.00.

See Fig. 2 for the specification changes.

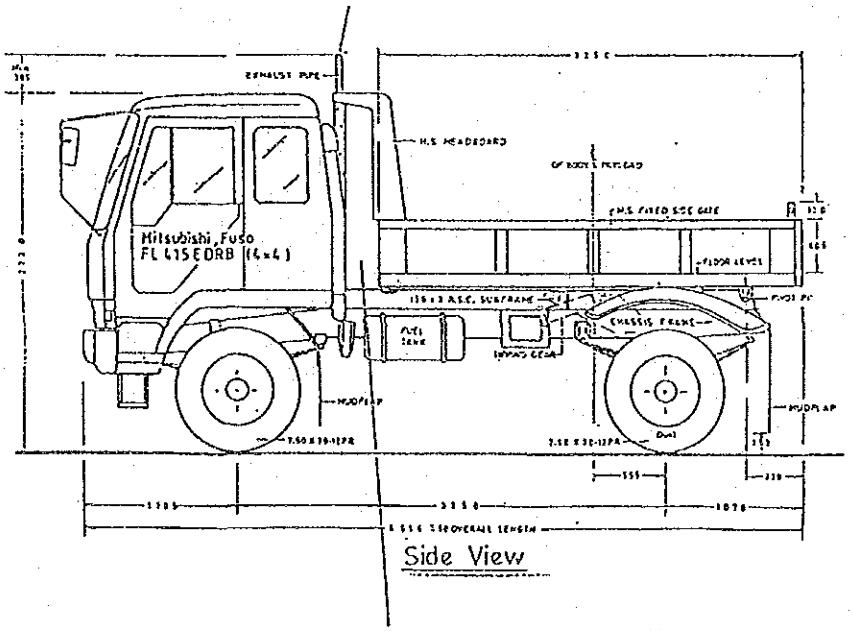
Fig. 2. Changes in dump truck specifications

Original (dealer) specifications



The exhaust pipe location has been changed.

Altered specifications. (From plan drafted in Malaysia)



A spare tire has been added.

4) Machinery Maintenance

The maintenance of machinery is supervised by experts at the locations of delivery.

Although it was originally planned that JICA would bear the costs of equipment maintenance, beginning in 1993 fiscal year, allocations for vehicle and equipment parts and fuel etc. were added to the working budget of the Perak State Forestry Department which is currently paying for equipment repairs and fuel purchases. Since the return to Japan by the long-term forest machinery expert, the maintenance of machinery has been overseen by the forest management expert concurrently with normal duties.

However, because of the physical impossibility of the forest management expert to perform the centralized maintenance of the many machinery used extensively by each section, for the time being, local personnel who use the vehicles most frequently have been appointed as the main operators of their respective vehicles, and are directly carrying out the maintenance of vehicles under the guidance and supervision of the appropriate experts (Table 6).

Table 6. Main operators of machines

Vehicle	Main operator		Supervisory section
	Name	Post	
Pajero (1)	Azmi	Driver	F/D
Pajero (2)	Dammulah	Driver	Nursery
Pajero (3)	Nizar	Supervisor	Nursery
Lite Ace	Zan/Rajah	Driver	Ipoh office
Landcruiser	Rajah	Driver	Ipoh office
Hilux	Minhat	Driver	Nursery
Fork lift	Minhat	Driver	Nursery
Bobcat	Dammulah	Driver	Nursery
Wheel loader	Azli	Driver	Forest road
Tractor	Minhat	Driver	Nursery
Station wagon	Zan	Driver	Ipoh office
Cargo truck (1)	A. Tajuddin	Driver	Silviculture
Motor grader	Azli	Driver	Forest road
Pajero (4)	A. Tajuddin	Driver	Silviculture
Pajero (5)	Hatta	Supervisor	Silviculture
Micro bus	Suppiah/Massaruddin	Driver	Nursery
Motor bike (1)	Azli	Driver	Forest road
Motor bike (2)	Naim	Forester	Silviculture
Dump truck (1)	A. Tajuddin	Driver	Forest road
Dump truck (2)	Suppiah	Driver	Forest road
Dump truck (2)	Massaruddin	Driver	Nursery

Even though local personnel hired specifically as drivers had been assigned as machinery operators, assistants have also been required to obtain driving licenses, and drive the said vehicle whenever necessary. Hence, vehicle insurance policies covering injuries have been purchased for each driver.

The duties of the main operator are as follow :-

① Routine inspection of the engine, wheel rotation and other aspects of the vehicle

② Washing the vehicle

③ Keeping a diary of machinery operation (see format) and submitting it at the end of each month

Although we have requested that the Perak State Forestry Department to assigned a full-time personnel to be responsible for machine maintenance, as mentioned above, it has been decided as a stop-gap measure, to have designated experts responsible for supervising the main operators assigned to each vehicle and providing practical guidance and supervision in the use and maintenance of machinery. In addition, the forest management expert was assigned to perform general duties and overall coordination concerning machinery maintenance.

(Format)

Operation Record of Machine

Month: Number of machine:

Day	Place of work	Division of days			Name of driver	Running distance (km)	Fuel consumption	Remarks
		Work	Repair	Rest				
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								
25								
26								
27								
28								
29								
30								
31								
Total								

3 Nursery

3-1 Overview Of Nursery Facilities, Etc.

1) Nursery Facilities

The nursery facilities are located at the top of a gentle slope in site A on a location previously used as a nursery in the past. Drainage is generally good on this flat site, where a nursery nearly two hectares in size had been developed.

Nursery construction began in June 1992, and the nursery beds, an office garage, smoking room, work room, warehouse, germination room, glass greenhouse, compost shed, generator room, oil storage house, car washing area, seedbeds with covering, and irrigation system were completed by December, 1992.

The total area of the nursery is 20,000 square metres, with 58 brick seedbeds for potted seedlings. Based on original Nursery Development Plan, high quality species seedlings (primarily dipterocarps) should be raised in Forestry Department nurseries in Kampong Chang and Papan. But due to unforeseen circumstances the two Forestry Department nurseries could not be utilized fully for this purpose and as a result, new seedbed had to be constructed in a hurry in Chikus.

In June 1993, an additional 62 seedbeds were prepared (bringing the total to 120) in order to supply the seedlings needed for experiments, experimental plots and afforestation on roughly 100 hectares annually, resulting in an annual maximum seedbed capacity of approximately 160,000 seedlings and the water sprinkler system was expanded in December 1993.

Table 7 lists the nursery facilities. The layout of facilities and seedbeds are shown in Figs. 3 through 5.

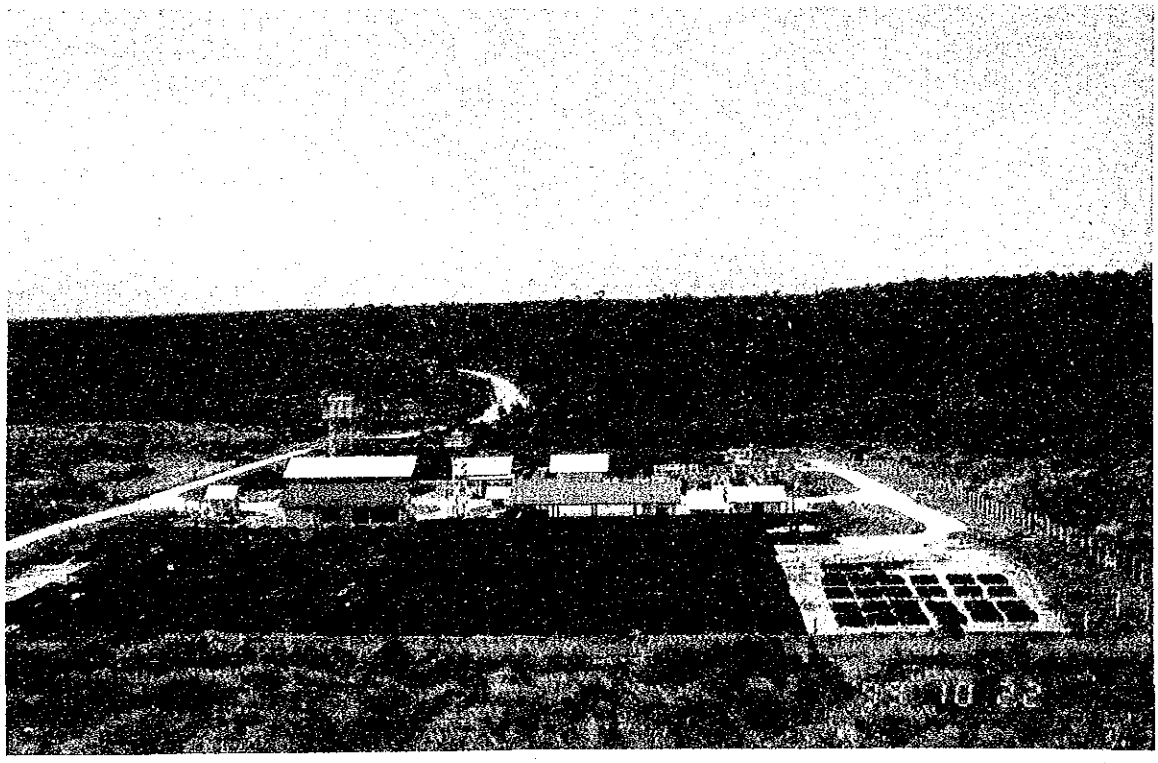


Photo - View of the entire nursery

Table 7. Nursery facilities

Name	Surface area	Application
Ground leveling for nurseries	20,000 m.²	100 m. x 200 m.
Seedbed and beds shading	360 m.²	1.2 m. x 5 m. x 60 seedbed
	720 m.²	1.2 m. x 10 m. x 60 seedbed
Nursery irrigation system		
Office	85.81 m.²	13.2 m. x 6.5 m.
Garage	126.0 m.²	7.0 m. x 18.0 m.
Smoking room	6.0 m.²	2.0 m. x 3.0 m.
Operating room	128.0 m.²	8.0 m. x 16.0 m.
Warehouse	30.0 m.²	5.0 m. x 6.0 m.
Germination room	30.0 m.²	5.0 m. x 6.0 m.
Glass house	30.0 m.²	5.0 m. x 6.0 m.
Compost shed	84.0 m.²	7.0 m. x 12.0 m.
Generator room	10.0 m.²	2.5 m. x 4.0 m.
Oil storage house	12.0 m.²	3.0 m. x 4.0 m.
Car-washing area	1 place	
Worker's bathroom	1 place	

Fig. 3. Layout of nursery facilities

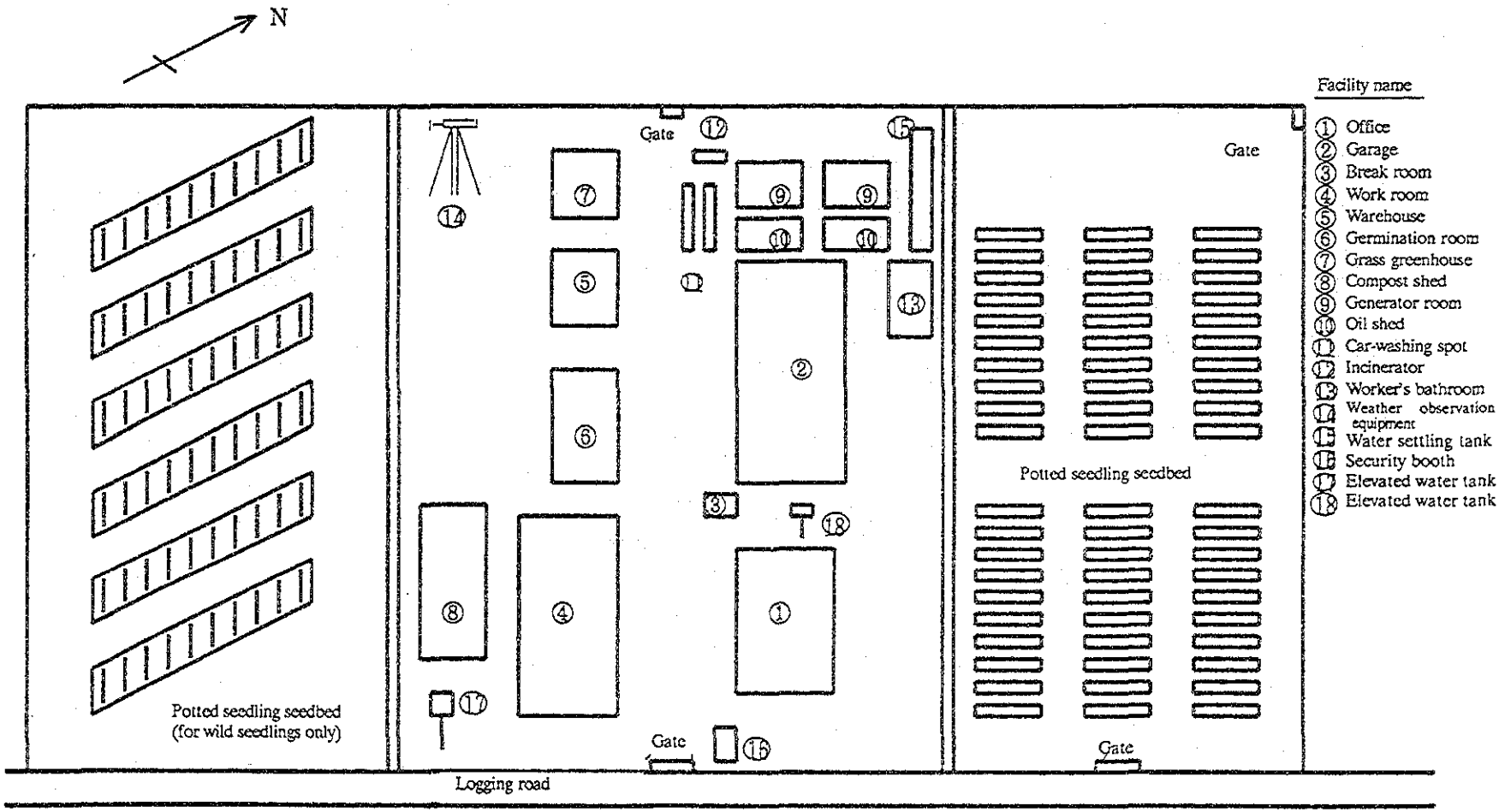
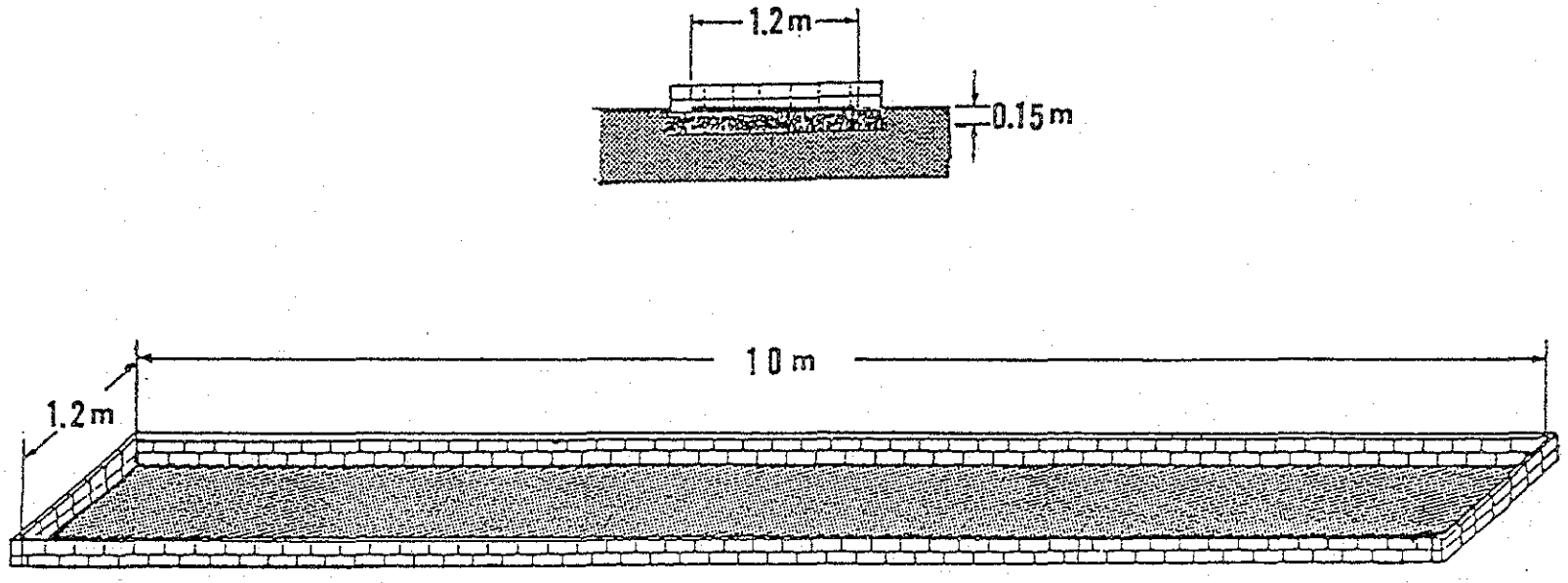


Fig. 4. Nursery bed



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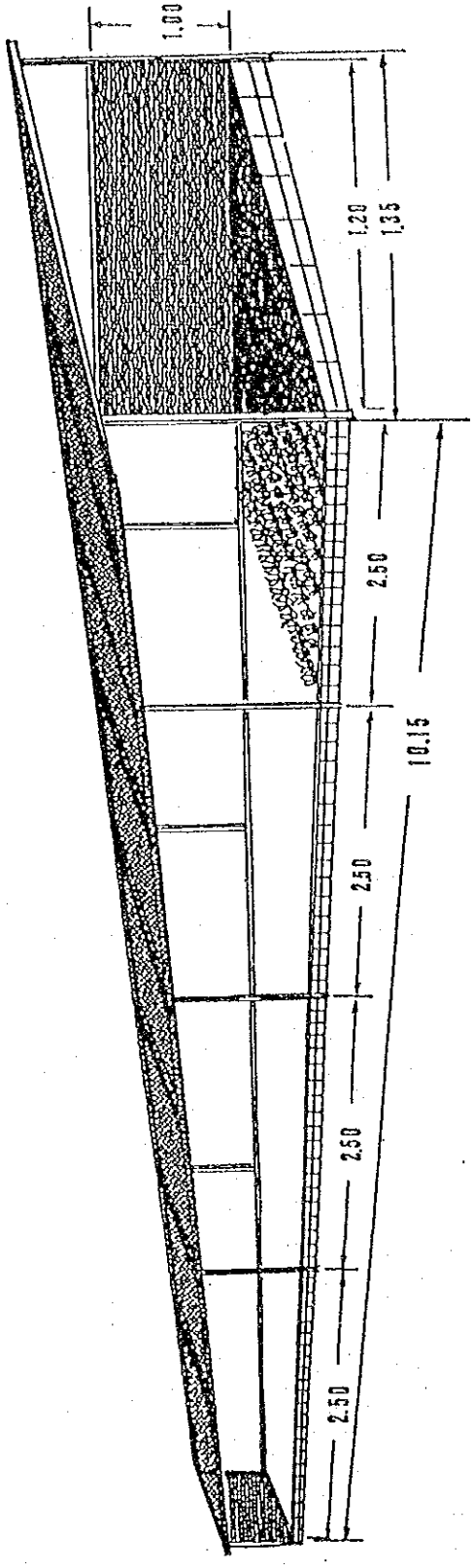

Fig. 5. Sun shade

2) Nursery Equipment

Nursery equipment currently in use is shown in Table 8.

Table 8. Nursery equipment

Machine name	Quantity	Use
Farm tractor	1	Transporting topsoil from natural forests, etc.
Bobcat	1	Preparing nursery ditches, soil trenches and work paths
Soil mixer	2	Mixing soil
Roller conveyer	10	Transporting pots and seedlings for planting
Fork lift	1	Transporting nursery tools, etc.
Soil sifter	2	Sifting and separating soil
Generator	2	Electricity use in nursery facilities
Hilux	1	Transporting pots and nursery tools
Cargo truck	1	Transporting seedlings from temporary nurseries
Pajero	2	Transporting seedlings during seed and wildings gathering

Photo - Transporting seedlings with the cargo truck (using the table for two-layer stacking)

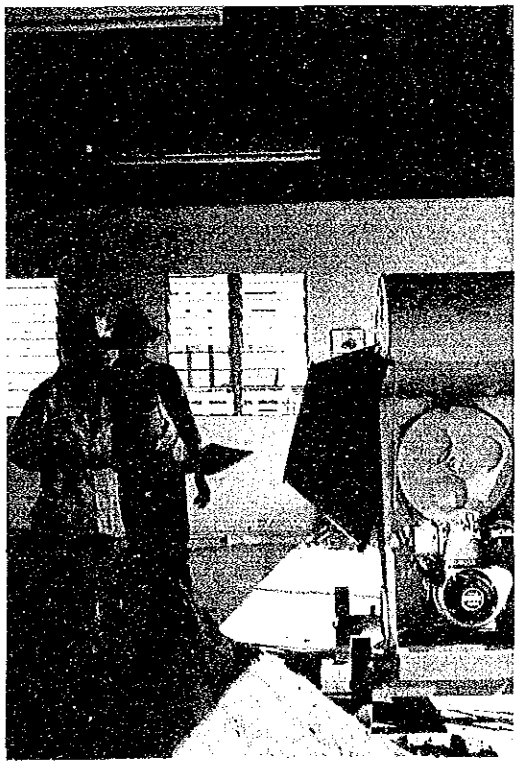

Photo - Using the soil mixer (mixing soil for potting)

3-2 Seeds And Seedlings Procurement

To satisfy the world's increasing appetite for timber, large areas of natural forest are harvested and replacement through natural regeneration is not proceeding as originally anticipated. And while the enrichment plantings of usable indigenous species are now being attempted throughout the tropics, there are many unresolved issues concerning basic and advanced knowledge and techniques for the production of the seeds and seedlings needed for this purpose.

In Malaysia there are many species of dipterocarps that flowers at intervals of two to three years in lowlands and six to seven years or more in mountainous areas, while the mature seeds of many species survive for only two or three weeks, depending on natural conditions.

Some of the problems in raising local indigenous species seedlings were difficulties of seed acquisition and procuring adequate amount of seeds of specific species. This project, too, faced problems of seed acquisition, which we have striven to overcome by collecting wildings from natural forests, raising them in nurseries and then replanting them in the field, while also giving proper consideration to seed growth and genetic preservation.

1) Seed Acquisition

The unpredictable periodicity of the flowering and fruiting of dipterocarps make it impossible to secure a stable supply of the needed seeds. The long-term storage of collected seeds also poses various difficulties: Mature seeds that fall to the ground decompose rapidly due to the attack of insects and micro-organisms, thus requiring proper timing in seed collection and a better understanding of flowering and fruiting in order to secure the needed seeds. In this project, information on flowering and fruiting is effectively collected and distributed through a network linking this project with the Perak State Forestry Department, other State Forestry Departments, FRIM and other organizations. In addition, special trees in Chikus natural forests and other areas have been designated for observation in order to ascertain the start of flowering, fruiting and other changes. Seed collection is then carried out promptly by seven-worker "collection teams".

(1) Locations Of Seed Collection Area

Information on dipterocarps and other species had been received since establishing the flowering/fruiting information network in December 1992. Upon receiving information, survey teams were dispatched to ascertain the state of flowering and fruiting, upon which seed collection teams were then dispatched in one-week shifts.

A dozen or so seed collection teams, each of which consists of 10 personnel includes 7 workers, 1 forester, 1 counterpart and 1 expert, had been dispatched between the period of March to October 1993 using the flowering/fruiting information network. They had succeeded in collecting roughly 200,000 seeds of 16 species of trees at three different locations (Table 9). A survey carried out in February 1994 also showed that in the forest under the jurisdiction of the Taiping district forest office, many species are currently flowering or fruiting, and that seeds are hence ready for collection. In seed collection there, it had been decided to focus on the following species: *Shorea leprosula*, *Shorea parvifolia*, *Dipterocarpus cornutus*, *Neobalanocarpus heimii*, *Shorea ovalis*, and *Hopea* spp.

Forestry Department surveys revealed an absence of private companies that collect and sell seeds, although there are private nurseries that raise dipterocarp seedlings from seeds and wildings.

(2) Seed Collecting Periods

Even among seeds of a single species of dipterocarp, there are significant differences in size and shape depending on the individual tree, the location of collection, whether the year in question had been a plentiful or poor one, and other factors. The period between flowering and seed maturity can be as short as one month or as long as six with a few exceptions. But, just as with seed size and shape, in many species there is considerable variation among individual seeds. The optimum time for seed collection (i.e., the time when seeds mature) is one of consistent dryness: externally, browning of the wings progresses and spreads to the seed coat itself. Because of the short life of seeds, the most important prerequisite in seed acquisition and cultivation is to collect seeds during this short period.

The period during which seeds of dipterocarps and other species are collected is not consistent, Table 9 shows the seed collecting schedule for 1993 as one example.

(3) Seeds Collecting Methods

Seeds were collected by one of these three methods: (1) positioning a net at a height of one metre around the mother tree and collecting the fallen seeds each day in the morning; (2) collecting seeds that have already fallen to the ground; or (3) climbing the mother tree and using shears to cut off seed-bearing branches. Of these three methods, climbing the mother tree to cut seed-bearing branches has resulted in the highest rates of germination. Because of their generally short life, dipterocarp seeds are generally hard to store and cultivate, while their high moisture content makes storage difficult. Hence, seeds collected must be immediately placed in polyvinyl bags and the bags sealed in order to prevent drying; when storing, they must be stored at relatively adequate temperatures (17 to 21 °C).

Because of the absence of seed preservation equipment in this project, we have striven to plant seeds within four to five days of collection, but work schedule conflicts have often prevented prompt planting. It is therefore vital that we construct a seed storehouse and coordinate storage with the nursery work schedule.

Thus, while amounts of seeds necessary for upcoming plantation are being secured, the difficulty in predicting flowering and fruiting requires that we continue to improve and enhance our flowering/fruiting information network.

Photo - Seeds being collected

Photo - The seed collection team in the field

Table 9. The collection of seeds for plantation seedlings in 1993 and 1994

	Species	Source	Date collected	Amount collected	No. of seed collected	Method of collection	Remarks
1.	*Dipterocarpus crinitus* (Keruing mempelas)	Besout	March 1993	15.0 kg Mostly rotten or damage by insects	700 seeds (1 kg)	Using nets to collect falling seeds	Of 15 kg collected, only 1 kg was used
2.	*Dipterocarpus cornutus* (Keruing gombang)	Bentong	April 1993	30.0 kg Mostly rotten or damage by insects	300 seeds (4 kg)	Collecting falling seed	Of 30 kg collected, only 4 kg was used
3.	*Shorea leprosula* (Meranti tembaga)	Gerik	August 1993	11.0 kg	13,500 seeds	Climbing the mother tree to cut off seed-bearing branches	
4.	*Shorea parvifolia* (Meranti sarang punai)	Bentong	Mar - Apr 1993	5.5 kg	7,500 seeds	Use nets to collect falling seeds	
5.	*Shorea macroptera* (Meranti melantai)	Gerik	September 1993	38.5 kg	25,800 seeds	Climbing the mother tree to cut off seed-bearing branches	
6.	*Shorea curtisii* (Meranti seraya)	Gerik	Aug - Sep 1993	9.5 kg	12,400 seeds	Climbing the mother tree to cut off seed-bearing branches	
7.	*Shorea pauciflora* (Meranti nemesu)	Gerik	August 1993	14.5 kg	11,000 seeds	Climbing the mother tree to cut off seed-bearing branches	
8.	*Shorea ovata* (Meranti sarang punai bukit)	Gerik	September 1993	19.7 kg	35,000 seeds	Climbing the mother tree to cut off seed-bearing branches	
9.	*Intsia palembanica* (Merbau)	Gerik	September 1993	72.2 kg	10,200 seeds	Climbing the mother tree to cut off seed-bearing branches	

Species	Source	Date collected	Amount collected	No. of seed collected	Method of collection	Remarks
10. *Parashorea densiflora* (Gerutu pasir)	Gerik	August 1993	10.2 kg	21,200 seeds	Climbing the mother tree to cut off seed-bearing branches	
11. *Sindora spp.* (Sepetir)	Gerik	September 1993	90.9 kg	22,300 seeds	Climbing the mother tree to cut off seed-bearing branches	
12. *Ochanostachys amentacea* (Petaling)	Gerik	September 1993	18.0 kg	3,200 seeds	Climbing the mother tree to cut off seed-bearing branches	
13. *Koompassia malaccensis* (Meranti melantai)	Gerik	September 1993	2.5 kg	1,300 seeds	Collecting falling seeds	
14. *Dacryodes spp.* (Kedondong)	Gerik	August 1993	2.0 kg	1,000 seeds	Collecting falling seeds	
15. *Hopea odorata* (Merawan siput jantan)	Gerik	September 1993	0.2 kg	300 seeds	Collecting falling seeds	
16. *Dipterocarpus cornutus* (Keruing gombang)	Gerik	Jul - Aug 1993	95.0 kg	6,900 seeds	Climbing the mother tree to cut off seed-bearing branches	
17. *Dialium spp.*	Gerik	October 1993	41.2 kg	23,000 seeds	Climbing the mother tree to cut off seed-bearing branches	
Total			475.9 kg	195,600 seeds		

2) Seedling Acquisition

Because of the difficulties encountered in collecting and preserving seeds, we are currently forced to rely on the use of wildings. Total seedlings produced in fiscal 1993 is shown in Table 10; roughly 26% of the high-quality tree seedlings were collected from wildings. However, the problems with wildings are (1) irregularity; (2) susceptibility to root breakage and other damage sustained during collection; and (3) the effects of changes in environment when relocated from the forest to the nursery.

The method adopted (based on the results of wildings experiments performed in fiscal 1992) is one in which collected wildings are potted and kept in temporary nursery near the collection site (in the forest) for a period of about 1 month. After the root had developed and growth observed, the seedling is then transferred to Project Nursery in Chikus.

In fiscal 1993 roughly 24% of the seedlings of high quality species were purchased from private nurseries (Table 10). However, the quality of these seedlings were inconsistent (for instance, except for certain species seedlings purchased from private nurseries in fiscal 1992, consisted almost entirely of wildings), and surveys of the said private nurseries have revealed that (1) wildings were collected haphazardly, often simply pulled out of the ground regardless of time of day; (2) shipments supposedly of a single species of wildings often contain other species due to inadequate species identification; (3) the use of pots intended for *Acacia mangium* results in the death of many seedlings as the pots became too small after the seedlings exceeded 8 months in age; (4) normally forest top soil is used as potting medium, but in many cases, private nurseries used clay soil which is hard and not suitable for healthy growth for the seedling; (5) possibly because of the absence of fertilization, many seedlings fail to take root and grow satisfactorily after replanting unless natural conditions are favourable.

Table 13 shows that in fiscal 1993, most of the seedlings purchased came from two of the five private nurseries that the project had contact with. Project members have on several occasions travelled to the actual nurseries to observe operations, checking the method of seedling cultivation and providing appropriate guidance. As a result, the quality of seedlings from private nurseries has improved since 1993 fiscal year, and we intend to expand the exchange of information and other regular tasks to include the activities of private nurseries.

Table 10. Seedlings produced between October 1992 and December 1993

Category		Number potted	Number of deaths	Seedlings returned to the wild	Survival rate	Percentage of of total seedling yield
Wildings		96,841 (8,399)	36,942 (3,841)	59,899 (4,558)	62%	55%
Seedlings grown from seeds		91,477 (27,254)	2,199	89,278 (27,254)	98%	
Seedlings purchased from nurseries		70,144 (15,000)	5,929 (1,602)	64,215 (13,398)	92%	23%
Seedlings received fro the Perak State Forestry Department		36,785 (9,400)	2,894	33,891 (9,400)	92%	12%
Seedlings purchased from other State Forestry Departments		27,428 (9,680)	1,535 (993)	25,893 (8,687)	94%	10%
Total	Fast-growing species	69,733	6,436	63,297	91%	23%
	High-quality indigenous spp.	252,942	43,063	209,879	83%	77%
	Total	322,675	49,499	273,176	85%	100%

Note:
1. Numbers in parentheses indicate the number of *Acacia mangium* and rubber trees (*fast-growing species*).
2. The above figures are from a survey performed at the end of December 1993.
3. Because of the many wildings that died after potting, only roughly 62% were eventually replanted in the field.
4. Seedlings grown from seeds had a high survival rate of 98%, with all deaths occurring after potting.
5. The figures for seedlings purchased from private nurseries (which were purchased after growing for 4 months to 1 year) include those damaged in transport and those that did not survive the change in environment.
6. Seedlings acquired from the Forestry Department of Perak and other states included some that were grown in temporary nursery and which were between 6 to 8 months or even a year old or more, many of which did not survive the change in environment.

(1) Wildings Acquisition

Using the data gathered by the survey team (flowering/fruiting), locations for seed and natural seedlings gathering were selected. Preparatory observation of conditions had to be carried out once the location and the expected gathering period were decided. The gathering period is said to be best two months after the ripe seeds have fallen.

Depending on the species, there are certain characteristics of their place of growth e.g. *Shorea leprosula* (Meranti tembaga) is found in relatively shady places, while *Shorea platyclados* (Meranti bukit) and *Anisoptera costata* (Mersawa) etc. grows well in open spaces and logged-over forest.

A seedling having 2 - 3 leaves and with a height of below 15 cm. would be most appropriate for picking. The seedling is placed in damp cotton rice bag to be carried to temporary nursery. One worker could gather 100 - 200 wildings at one time; therefore a team could gather 5,000 wildings during the period.

See Table 11 for the quantities of each species of wildings used in this project.

Photo - Wildings collected

Table 11. Wildings production in relation to worker's man/day

Species	Number of seedlings potted	Number of seedlings returned to the wild	Success rate	Remarks
(1) *Shorea leprosula*	8,334	4,447	53%	
(2) *Shorea parviflora*	3,322	1,505	45%	
(3) *Pentaspadon motleyi*	18,255	9,024	49%	
(4) *Hopea odorata*	6,552	4,960	76%	
(5) *Palaquium spp.*	11,371	7,531	66%	
(6) *Dryobalanops aromatica*	6,172	4,318	70%	
(7) *Shorea macroptera*	7,641	3,565	47%	
(8) *Calophyllum spp.*	3,845	2,569	67%	
(9) *Parashorea spp.*	9,525	6,825	72%	
(10 *Dipterocarpus cornutus*	1,598	1,435	80%	
(11 *Dacryodes spp.*	1,490	835	56%	
(12 *Koompasia spp.*	1,315	1,127	86%	
(13 *Shorea pauciflora*	1,943	1,943	100%	
(14 *Shorea hypochra*	1,900	1,577	83%	
(15 *Shorea assamica*	2,200	2,050	93%	
(16 *Acacia mangium*	8,399	4,558	54%	
(17 Others	2,979	1,630	55%	
Total	96,841	59,899	62%	
Number of workers/day	746			
Number of seedlings collected per worker/day	130			

Photo - A temporary nursery for wildings

Photo - Spraying transpiration control chemical prior to transport

(2) Viable Seedlings

Species of dipterocarps that fruits annually are rare, most usually flowering or fruiting occur only once every several (or even up to 20 years). In addition, their seeds unfortunately lack the hardiness to survive prolonged storage and rapidly lose their ability to germinate if not planted within one week of collection. However, the establishment in December 1992 of the flowering/fruiting information network, fruiting and other factors had enabled the successful collection of the seeds of many species of dipterocarps and enhanced project effectiveness in other areas as well. Of vital importance is systematizing nursery work preparations in order to plant seeds immediately upon collection, thus increasing the rate of germination.

The figures in Table 12 represent the number of viable seedlings from natural forests throughout Peninsular Malaysia. Some species in this table are now flowering and fruiting in Taiping (Perak), the project's nursery team was dispatched in February 1994 and is currently collecting these dipterocarp seeds.

Table 12. Viable seedlings collected

Species	Viable seedlings	Place of collection
(1) *Shorea leprosula*	12,265	Location scheduled for clearing in Gerik
(2) *Shorea parviflora*	6,336	Bentong district forest office in Pahang state
(3) *Intsia palembanica*	3,155	Natural forests in Gerik
(4) *Parashorea spp.*	2,221	Location scheduled for clearing in Gerik
(5) *Shorea macroptera*	12,513	Along the highway in Gerik
(6) *Dipterocarpus cornutus*	2,020	Location scheduled for clearing in Gerik
(7) *Shorea pauciflora*	10,350	Location scheduled for clearing in Gerik
(8) *Shorea ovata*	13,039	Location scheduled for clearing in Gerik
(9) *Sindora spp.*	1,019	Along the highway in Gerik
(10 *Acacia mangium*	27,254	Project site in Sabah
(11 *Dialium spp.*	633	Along the highway in Gerik
(12 *Shorea curtisii*	672	Along the highway in Gerik
Total	96,477	

Although the flowering/fruiting information network will make possible annual seed collection, seed yields are expected to vary considerable from year to year. Because the inability to perform nursery work on schedule, nursery work schedules must be coordinated so that seeds can be stored for a certain period of time in the event of good flowering season.

(3) Commercially Purchased Seedlings

A survey of private nurseries located in the state of Perak and a few other states indicate that they mostly concentrate in producing rattan seedlings for Community Forest Project and also ornamental trees for Urban Forestry Projects. Little emphasis was given to producing high quality trees seedlings. Recently, through the "Enrichment Planting" project carried out by Forestry Department, part of the seedlings were procured from private nurseries but the amount only made up a small percentage of the total requirement.

Because of their minimal facilities, private nurseries were not organized for high scale production and depend mainly on wildings, with seedlings grown from seeds representing only a small percentage of the total.

However, there had been more frequent in the frequency of consultation with private nursery operators, who have begun growing seedlings of high-quality species especially for this project, and productions from these private nurseries are increasing. We intend to pursue seedlings acquisition while striving to ensure a constant supply from private nurseries, which included requesting these nurseries to produce, for 1994 fiscal year, species which were not available for this project.

See Table 13 for figures on the seedlings purchased from private nurseries in 1993 fiscal year.

(4) Seedlings From State Forestry Department Nurseries

The seedlings from Perak Forestry Department nurseries were not sufficient for project's needs. Therefore in 1992 and 1993, some selected seedlings which were not available were procured from other State Forestry Departments nurseries such as from Pahang and Negri Sembilan.

Both of these states nurseries raised most of the seedlings from wildings and so far the project had no problem in getting the cooperation and supply of these seedlings which the project required.

However, various steps must be taken to offset the current difficulty in annual supplies of other species for experimental plots, such as using the flowering/fruiting information network to find new species in the nurseries of State Forestry Department.

See Table 14 for an overview of seedlings provided by each State Forestry Department in 1993.

Table 13. Seedlings purchased from private nurseries

Species	Private nurseries					
	Teren-gganu	Ramadan	Rim	Kedah	Ah	Total
(1) *Shorea leprosula*			1,000			1,000
(2) *Neobalanocarpus heimii*	11,000					11,000
(3) *Hopea odorata*	4,000					4,000
(4) *Palaquium spp.*				2,889		2,889
(5) *Shorea laevis*				4,446		4,446
(6) *Parashorea spp.*				4,119		4,119
(7) *Drybalanops aromatica*		892	8,000	2,698		11,590
(8) *Alstonia spp.*			1,000			1,000
(9) *Cinnamomum spp.*				500		500
(10 *Shorea braceolata*				5,000		5,000
(11 *Acacia mangium*					15,000	15,000
(12 *Scaphium spp.*				4,000		4,000
(13 *Calamus mana*				3,600		3,600
(14 *Parkia spp.*				500		500
(15 *Durio spp.*				1,000		1,000
(16 *Toona spp.*				500		500
Total	15,000	892	10,000	29,252	15,000	70,144

Note: 1. Figures represent the numbers of seedlings.
2. The private nurseries where seedlings were purchased are as follows :-
   1) Terengganu (a commercial vendor)
   2) Ramadan (Ramadan Management Services)
   3) Rim (Rim Nursery Sdn. Bhd.)
   4) Kedah (Seri Alor Star, Kedah)
   5) Ah (En Teong Ah Hing, Sitiawan, Perak)

Table 14. Seedlings from State Forestry Department

Species	Perak			Negeri Sembilan	Pahang	Total
	Manong	Papan	Gerik	Mantin	Raub	
(1) *Shorea leprosula*	11,000			748		11,748
(2) *Shorea parvifolia*	7,000			2,000		9,000
(3) *Intsia palembanica*			520			520
(4) *Tectona grandis*			500			500
(5) *Shorea acuminata*	2,201			8,000		10,201
(6) *Shorea laevis*				500		500
(7) *Endospermum malaccense*				3,000		3,000
(8) *Heritiera spp.*				1,000		1,000
(9) *Dipterocarpus cornutus*			426			426
(10 *Shorea hopeifolia*	890					890
(11 *Shorea singkawang*		3,413				3,413
(12 *Acacia mangium*		9,400		9,680		19,080
(13 *Agathis dammara*		435				435
(14 *Scaphium spp.*						500
(15 *Shorea hypochra*		1,000				1,000
(16 *Hevea brasiliensis*				500		500
(17 *Swietenia macrophylla*				500		500
(18 *Shorea ovalis*					500	500
(19 *Shorea dolichocarpa*					500	500
Total	21,091	14,248	1,446	26,428	1,000	64,213

Note: 1. Figures represent number of seedlings.
2. Nurseries in Perak are those of the district forest offices.
3. Nurseries in Negri Sembilan were also used for afforestation offices and are larger in size.
4. Nurseries in Pahang had been prepared within the boundaries of afforestation offices in the western districts and are small in size.