Report for the Study on

THE AFFORESTATION AND SETTLEMENT PROJECT IN DIVISION V OF THE BENGKOKA AREA OF THE STATE OF SABAH, MALAYSIA

NOVEMBER 1984

JAPAN INTERNATIONAL COOPERATION AGENCY

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Preface

In response to the request of the Government of Malaysia, the Japanese Government decided to make a feasibility study on the Afforestation and Settlement Project in the Division V of the Bengkoka Area, Sabah, and entrusted the survey to the Japan International Cooperation Agency (JICA). JICA sent a survey team headed by Mr. Takashi Fujimura to Kuala Lumpur and the State of Sabah in February and September 1984.

The team had discussions with the officials concerned of the Government of Malaysia and conducted a field survey in Bengkoka area, Sabah. After the team returned to Japan, further studies were made and this report has been prepared.

I hope that this report will serve for the development of the Project and contribute to the promotion of friendly relations between our two countries.

I wish to express my deep appreciation to the officials concerned of the Government of Malaysia for their close cooperation extended to the team.

November 1984

Keisuke Arita

President

Japan International Cooperation Agency

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1. Place Name

2. Abbreviations

cm	centimeter
DBH	Diameter at breast height
EIRR	Economic Internal Rate of Return
FIRR	Financial Internal Rate of Return
ha	hectare = 10,000 m^2
Hp	Horse power
JICA	Japan International Cooperation Agency
JOFCA	Japan Overseas Forestry Consultants Association
KVA	kilovolt-ampere
M$	Malaysian Ringgits
m	meter
mm	millimeter
m^2	square meter
m^3	cubic meter
MW	megawatt
SAFODA	Sabah Forestry Development Authority

Members of the Study Team

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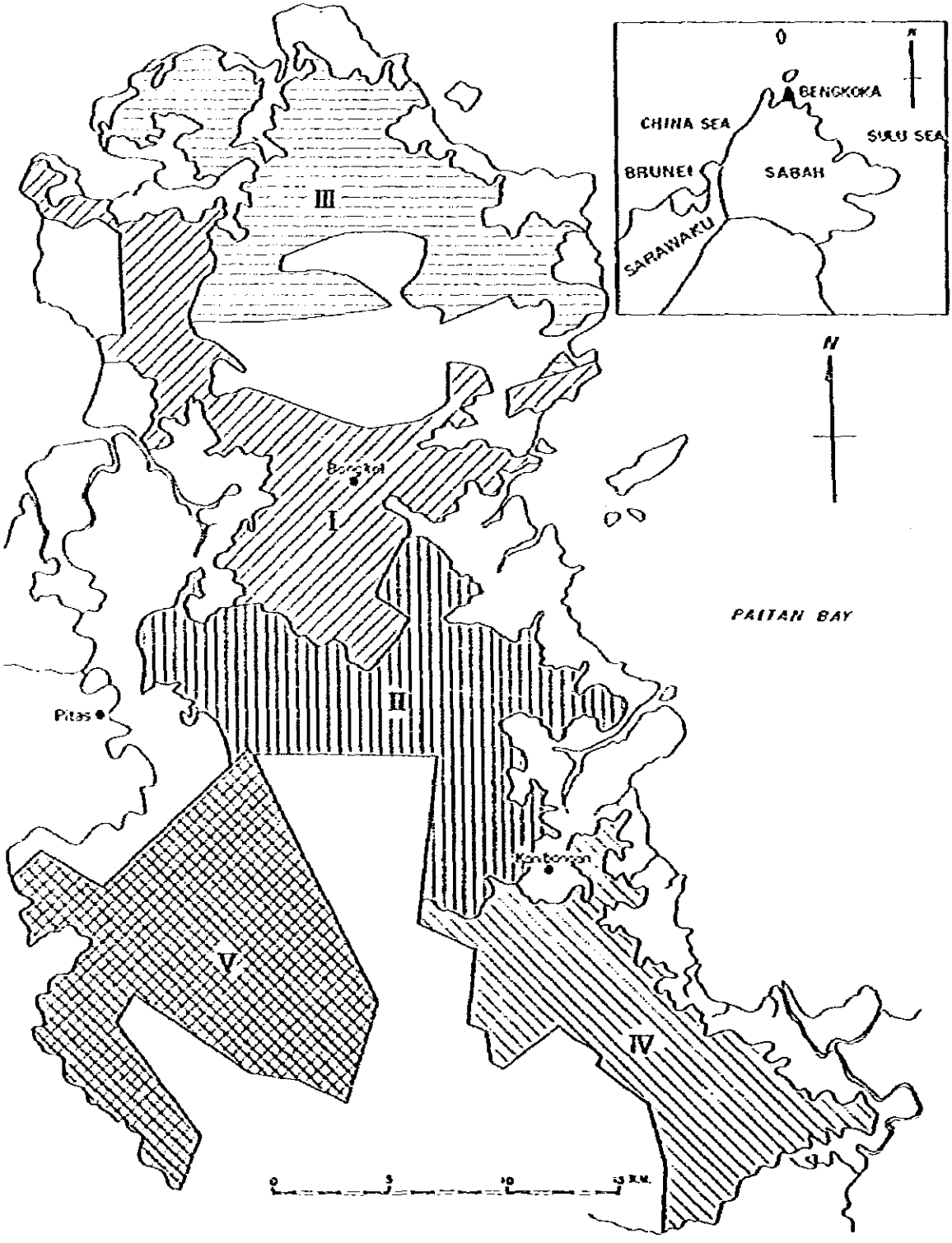
HARADA, Noriaki	Soil Analysis
FUJINAMI, Koichi	Preparation of Working Plan

DIVISON I-V OF THE AFFORESTATION AND SETTLEMENT PROJECT IN THE BENGKOKA AREA



1. Summary and Conclusion

The Government of Japan and the Government of Malaysia agreed on the SCOPE OF WORK on September 15, 1983, to jointly conduct a study of the afforestation and settlement plan of Bengkoka in Sabah, Malaysia. In the SCOPE OF WORK the objectives of the study are detailed as: the review of the Bengkoka Afforestation and Settlement Project (hereinafter called "the project" or "the original plan") devised by the Malaysian Government, and the formulation of an afforestation and settlement plan for Division V (hereinafter called "the modified plan"). Division V was chosen out of the five divisions of the Bengkoka Project.

As the details are described later in this report, the study is summarized here and the conclusion presented along with the above objectives.

1-1 Summary

The concept and approach of the original plan are innovative. The Bengkoka Peninsula, the poorest area in the state of Sabah, has been turned into extensive grasslands as a result of continuing shifting cultivation. The fact that such an area was selected for the afforestation and settlement project will not only bring about an improvement in the living standards and welfare of the local inhabitants, but also provide a good example for other Southeast Asian countries placed in a similar situation.

Further, if a large-scale re/afforestation on a grassland in a tropical region succeeds it will make a great contribution to development in the region as a whole.

The modified plan has been worked out after examining the feasibility of the original plan and has established a comprehensive implementation plan for Division V. The main items of the modified plan are described as follows:

- Determination of Tree Species

Judging from the study results of the existing afforested areas and data including

related literature, *Acacia mangium* is a suitable choice. To prevent disease and insect damage, however, it is desirable to introduce other species; therefore, the modified plan selects *Paraserianthes falcataria* and *Gmelina arborea* as species to be mixed on ridges or along streams.

o Re/afforestation Area

Though the original plan projected 7,200 hectares as the afforestation area in Division V, it is decided to plan 9,000 hectares in the modified plan as a result of the field study.

o Rotation Period

As against the 12 years in the original plan, the modified plan determined the rotation at 15 years, considering the tree size most profitable for use (over 30 cm in DBH) and current annual increment.

o Operation Period and Cycle

The original plan divides the operation period into the following three stages:

First stage	6 years	planting period
Second stage	6 years	tending & protection
Third stage	6 years	harvesting period

In consideration of the stable employment of the settlers and efficient utilization of the nursery facilities, etc. the modified plan projected annual planting area as:

$$\frac{\text{Total Re/afforestation area}}{\text{Rotation period}} = \frac{9{,}000}{15} = 600 \text{ hectares}$$

o Tending Plan

After reviewing in detail the procedures for weeding, vine cutting, improvement cutting, thinning, pruning and fertilizing in the original plan, the following schedule is prepared for the modified plan.

(Number of Operations per rotation)

Works	Original plan	Modified plan
Weeding	5	3
Vine cutting	–	2
Improvement cutting	–	2
Thinning	2	2
Pruning	3	2
Fertilizing	7	1

o Nursery Plan

According to the original plan, the central nursery will provide all the seedlings required in Division I, and 50 percent of those needed in Divisions II-V. Considering that it is desirable that the soil and weather conditions of the nursery should be similar to those of the planting site, that the nursery and the planting site should be in close proximity, and also that the stable employment for the settlers should be provided, it is decided in the modified plan that all the seedlings required for Division V will be supplied by the nursery built in the Division V area.

o Procurement of Good-quality Seeds

Though the original plan does not deal with this matter, the modified plan involves the selection of plus trees and the clone layout in seed orchards under the instruction of tree breeding specialists.

o Forest Road Plan

In the modified plan the length of the forest road was projected at 46 kilometers, and forest tracks at 135 kilometers, during 15 years after the start of operations. The construction of these roads is to be carried out through the contract system, while road maintenance will be undertaken through the direct operation system. The forest road network will be constructed around the re/afforested area, in combination with firebreak belts in order to prevent forest fires.

o Base of Division V

Though the original plan locates the base at Sulakalong, the modified plan sets the base at the confluence of the Bengkoka and Mandamai rivers in order to secure a stable water supply—essential both for the life of the local inhabitants and the proposed nursery.

o Measures for Stabilizing and Improving the Settlers' Life

The original plan was also reviewed by the Sabah Forestry Development Authority (SAFODA). According to the plan, by working at least 150 days a year, settlers will be entitled to receive a share of the revenue, equivalent to 1 acre plantation (0.4 hectares), and at harvesting time, will be guaranteed earnings equivalent to a maximum of 15 acres (6.07 hectares). While settlers receive a share of one-third of gross revenue at harvesting time, they must pay a proportion of the costs of facilities (housing, electricity, water supply, etc.).

The modified plan, however, changed this share to one-third of net profit of the project, while all the facilities' costs will be borne by the State of Sabah.

In addition, the modified plan will also provide 200 hectares of common land for agriculture and agroforestery, and include instruction in the techniques of agroforestry.

o Administration and Management

The Administrative Office of Division V will be established under the control of the General Manager of SAFODA. Comprising Administrative, Settlement, Plantation Sections, as well as a Silviculture Research Center, there will be thirty-three personnel (including a technical adviser). The technical adviser will give advice to the Project Manager of Division V on overall management, and provide technical instruction in the carrying out of operations.

o Financial Analysis

The modified plan estimates the total cost at M$1,250.1 million for the fifty years after the start of the operations, and the total revenue from final cutting and thinning at M$2,914.7 million. The financial internal rate of return (FIRR) has been calculated at 11.5 percent. The annual cash account will be in the black for the first time in the seventeenth year when final harvest begins and accumulated debts will be cleared by the twenty-second year.

The FIRR resulting from SAFODA's operations amounts to 13.7%, if the expenditure on the community, which should be borne by other government agencies, is deducted from the total expenditure.

o Economic Analysis

The economic internal rate of return (EIRR) is 16.1%, when estimated on the basis of the economic benefits obtainable through implementation of the modified plan. This rate represents only the economic benefits arising from re/afforestation.

If, however, the benefits coming from settlement, which can not be assessed in concrete terms—settlement of farmers engaged in shifting cultivation, improvement of living conditions and creation of employment opportunities—, are taken into account, the overall improvements are considerable.

o Social Development

In the modified plan, as in the original plan, efforts were made to develop a plan whereby a thorough local sociological survey could be conducted on such items as the

historical development of the local communities, differences in folklore and custom, living standards, and the level of education, to facilitate the active participation of the local people in the project.

- Local Inhabitants' View of Social Development

A field survey showed that the local inhabitants have a positive attitude towards this program. Of the 381 households surveyed 376 expressed their willingness to participate in the project. What must be noted in developing is that the residents' motives for participation are that public facilities, such as electricity, water supply, a school, a clinic, etc. will be provided; they will be provided houses; and they will receive income to improve their livelihood. Accordingly, the plan must be implemented systematically in order not to disappoint them, and any actions likely to affect the existing social system should be avoided.

1-2 Conclusion

As outlined above, the modified plan of Division V is feasible, because: the main tree species for plantation *(Acacia mangium)* is highly promising, the local inhabitants are positively inclined towards the project, and the expectations are high for prospective rates of return following the financial and economic analyses.

In proceeding with the plan, however, the investment burden at the beginning will be large and it will take considerable time to create revenue, thereby creating the need for aid from all the organizations concerned, particularly SAFODA, the project implementation agency.

Finally, it must be emphasized that however excellent the plan may be, it will not produce good results if the system of field operations is inadequate. Therefore, particular consideration should be given to the establishment of the field organization and the training of engineers. Further, whatever excellent re/afforested area may be built, immeasurable losses will be incurred if it is damaged or destroyed by forest fire. Therefore, top priority must be given to fire prevention.

2. The Background to the Project

In order to fully understand this report some knowledge of the background to the project is needed. In this section, the prevailing situations in forests and forestry, the present socio-economic conditions, as well as the importance, objectives, administration and management of the project, and the status of Division V will be discussed.

2-1 Forests and Forestry in Sabah State

2-1-1 Forests

Covering an area of 4,605,000 ha (as of 1982), and accounting for 62% of the total area of Sabah State, forests are an important resource for the State. However, there has been a remarkable decrease compared with the 1977 figure when forests accounted for 75%. As shown in Table 2-1, undisturbed high forests, which play a major role in timber production, have decreased at an average annual rate of 195,200 ha, from 2,675,000 ha in 1977 to 1,699,000 ha in 1982. Although there are no exact figures for the annual average harvesting area, undisturbed high forests will be depleted within ten years if the present rate of decrease continues. Although some parts of these forests including protected forests will be reserved by effective forest policies in Sabah, it is obvious that productive forests will continue to decrease.

(a) Natural Forests

Forests rich in *Dipterocarpaceae*—important for production—are in large part found on the east coast, while there are less in the western regions where agricultural people like the *Rungus* and *Orang Sungei* live by repeating shifting cultivation in forest areas. The main species of *Dipterocarpus* forests are as follows:

o Lowland *dipterocarpus* forests

Parashorea malaanonan forests: near the coast

Parashorea tomentella/Eusideroxylon zwageri forests: in the northeast lowlands

Table 2-1 Forest Areas in Sabah State

(1,000 ha)

Vegetation type	1977	1982
Mangrove forest	348	331
Transitional beach and fresh water swamp forest	204	194
Montane forest	772	772
Undisturbed high forest	2,675	1,699
Other forest (immature & disturbed)	1,518	1,609
Total	5,517	4,605

Notes: (1) 1977 Figures are from the Annual Report of the Forest Department for the year 1978, Sabah State.
(2) 1982 Figures are from the Annual Bulletin of Statistics, Sabah, 1982, Department of Statistics, Malaysia (Sabah Branch)

Shorea/Eusideroxylon zwageri forests: mainly in the southeast areas

Shorea/Dipterocarpus forests: mainly in poor soils and as secondary forests

Parashorea malaanonan/Dryobalanops lanceolata forests: in the western hill areas

- Hill *Dipterocarpus* forests

Shorea forests: Selangan Batu forests: on steep hillsides and in the highlands

Dipterocarpus/Shorea forests: on eastern and northern steep sandstone hillsides of the coastal area

(b) Man-made Forests

As for plantations, there are *Eucalyptus deglupta, Paraserianthes falcataria, Gmelina arborea, Pinus caribaea,* and *Acacia mangium* which were planted by Sabah Softwood Sdn. Bhd. in Tawau. They are in generally good results except for *Pinus caribaea* and some areas of *Eucalyptus deglupta.*

Sabah Softwood Sdn. Bhd., a joint venture of the North Borneo Timbers Bhd. and the Sabah Foundation, began re/afforestation activity in 1974, and by 1982 had developed a plantation of 23,000 ha. The percentages of planted tree species are as follows:

Paraserianthes falcataria	42%
Eucalyptus deglupta	29
Gmelina arborea	15
Pinus caribaea	4
Acacia mangium	3
Others	7
Total	100%

On the west cost, *Acacia mangium* has been planted by SAFODA mainly on the grasslands which were depleted as a result of repeated shifting cultivation. It grew relatively well despite being situated on grasslands of bad soil condition.

A total area of 16,000 ha was re/afforested by SAFODA from 1979 to September 1983, and the Division I of Bengkoka Project for re/afforestation is presently being carried out with confidence based on the re/afforestation results of the existing plantations.

2-1-2 Forestry

Forestry in Sabah State remains economically of great importance, though production forests have been decreasing at a rapid rate as mentioned in the previous section. Earnings from forestry, for example, amounted to 65% of total state revenues in 1981 (Table 2-2). These earnings consist of royalties on exportable logs, and one of the reasons the state introduced re/afforestation using fast growing species is to maintain these high earnings from forestry.

Table 2-2 State Revenues

(M$1,000)

Year	Revenues	Earnings from forests	Percentage
1977	716,292	496,985	69
1978	777,282	510,298	66
1979	1,439,748	1,109,999	77
1980	1,538,251	1,093,543	71
1981	1,206,110	782,790	65

In order to restrict log exports and to encourage the development of domestic wood processing industries, Sabah introduced a policy, instituted in 1977, which sought to reduce by half the 1976 log export level within five years and to reduce the royalty of logs to the industries. These are substantive policies for promoting the timber industry. In the report, The State of Food and Agriculture of 1982, FAO reports that Malaysia (especially Sabah State) and Paraguay have recently established sawmill industries to produce exportable sawtimber, in order to replace the logs which they previously exported.

As indicated in Table 2-3, the percentage of log exports in total production fell from

95% in 1978 to 84% in 1982. It is noticeable, however, that the implementation of the above-mentioned policy aimed at halving log exports has been considerably delayed.

Table 2-3 Production and Exports of Logs in Sabah

(1,000 m³, %)

Year	Production		Exported volume	Percentages
	Total	Logs		
1978	13,116	13,077	12,326	95
1979	10,867	10,728	9,717	90
1980	9,613	9,064	8,210	91
1981	11,971	11,287	8,697	77
1982	12,917	11,739	9,827	84
1983			9,474	

Source: Department of Statistics, Malaysia (Sabah Branch), Annual Bulletin of Statistics, Sabah, 1982.
Note: Total excludes fuel wood.

The majority of logs produced are of the *Dipterocarpaceae*, and there are, in particular, many *Shorea* species called *Seraya*. According to Table 2-4 showing the breakdown of the species of exported logs in 1983, *Red Seraya* has the highest share (35%), followed by *White Seraya* (21%), *Kapur* (11%), *Yellow Seraya* (10%), *Keruing* (9%) and *Selangan Batu* (6%). The exported log volume of these *Dipterocarpaceae* accounts for 92% of all tree species.

Table 2-4 Sabah Log Exports by Species (1983)

(1,000 m³, %)

Species	Volume	Percentage
Seraya, Red	3,353	35
Seraya, White	1,933	21
Seraya, Yellow	967	10
Kapur	1,002	11
Keruing	847	9
Selangan Batu	587	6
Sub total (Dipterocarpaceae)	8,739	92
Other	735	8
Grand total	9,474	100

For export, straight, full-bodied and good-quality logs with an end diameter of 60cm and over are selected, and *Seraya* species in particular are used for plywood and sawtimber

because of their color and quality. Selective cutting has been carried out to harvest such large trees, but increased costs as a result of the logging in inland forests, and higher prices owing to the decrease in the number of good-quality trees, made it possible to improve the techniques used to produce plywood even from small trees. To harvest the smaller trees selective cutting has been carried out a couple of times at the same place resulting in the degradation of logged forests.

2-2 Socio-economic Conditions in the Bengkoka Project Region

2-2-1 Introduction to Bengkoka

The population in Bengkoka Peninsula area was estimated at 18,480 in the 1980 national census, and at about 18,000 in a survey carried out by McGowan International (Australia) in 1983. (Statistics quoted in this section are based on the Bengkoka Settlement Planning Study; McGowan International, 1983.)

According to the survey into the 115 local communities in Bengkoka, *Runggus* is the largest in terms of ethno-linguistic grouping with 1,187 households (35.6%), and the second largest is *Orang Sungei* with 770 households (23.1%); the remaining groups consist of maritime people such as the *Bajau* and the *Ubian*, and the farmers of *Dusun* origin such as the *Tembanuoh, Kimaragan*, and *Kadazan*.

By major economic activity, 2,280 households (68.3%) are engaged in agriculture, 530 (15.8%) in fishing, with the remainder comprising public servants, merchants and salaried workers.

Reference is made to tribes and occupation because such classifications are considered useful for facilitating the project in view of their interrelation with the ecosystem.

Table 2-5 shows the major economic activities in each of the main tribes. Figures 2-1 and 2-2 show the distributions of tribes and occupations, respectively.

Table 2-5 Major Economic Activities by Tribe in Bengkoka

(Units: No. of Local Communities)

Tribes	Total	Major activities						
		Fishery	Agriculture			Wage labor	Wage labor and agriculture	Wage labor and fishing
			Settled	Settled and shifting	Shifting			
Bajau origin	20	17	2			1		
Bajau/Orang Sungei	1	1						
Orang Sungei	18	5	9	1	1	1		1
Runggus	43		22	13	7	1		
Runggus Dusun origin	6		3	1	2			
Dusun origin	19		9	6	4			
Dusun/Orang Sungei	1		1					
Chinese	1					1		
Mixture	6		1	2		2	1	
Grand total	115	23	47	23	14	6	1	1

Note: Some local communities consist of a single tribe and other local communities are a mixture of various tribes. In the latter case, a tribe accounting for three quarters or more is regarded as being dominant. Some dominant tribes accounting for less than three-quarters are also included.

(a) Maritime People

The maritime people of *Bajau* origin, such as the *Bajau, Ubian* and *Suluk* are found from the river-mouth of the Telega to the northern extremity of the peninsula, and from the river-mouths of the Karangan, Bungai and Kanibongan along the east coast, to the lower basin. Almost all these tribes live by fishing. The *Orang Sungei* (meaning river people) tribe lives in the middle basins of the Melubang and Bengkoka. The majority, except for those engaged in fishing, settle on farm land. The main crop is coconut, and both rice grown in paddy fields and rubber are also cultivated.

(b) Runggus

Runggus are found widely in the upper reaches of those rivers that adjoin forests. They are agricultural people engaged in conventional shifting cultivation. The recently prevailing cash crop economy, the decrease in suitable areas for shifting cultivation and the guidance from the Agricultural Department have encouraged them to cultivate rice (in paddy fields) and coconuts over wide areas.

The *Runggus* is the largest tribe in the 43 local communities in Bengkoka. Of these 43, 21 comprise only *Runggus*, and in the remaining 22 colonies the *Runggus* live with other tribes, although they are few in number. The forty-three local communities have a total of

Figure 2·1 Distribution of Tribes

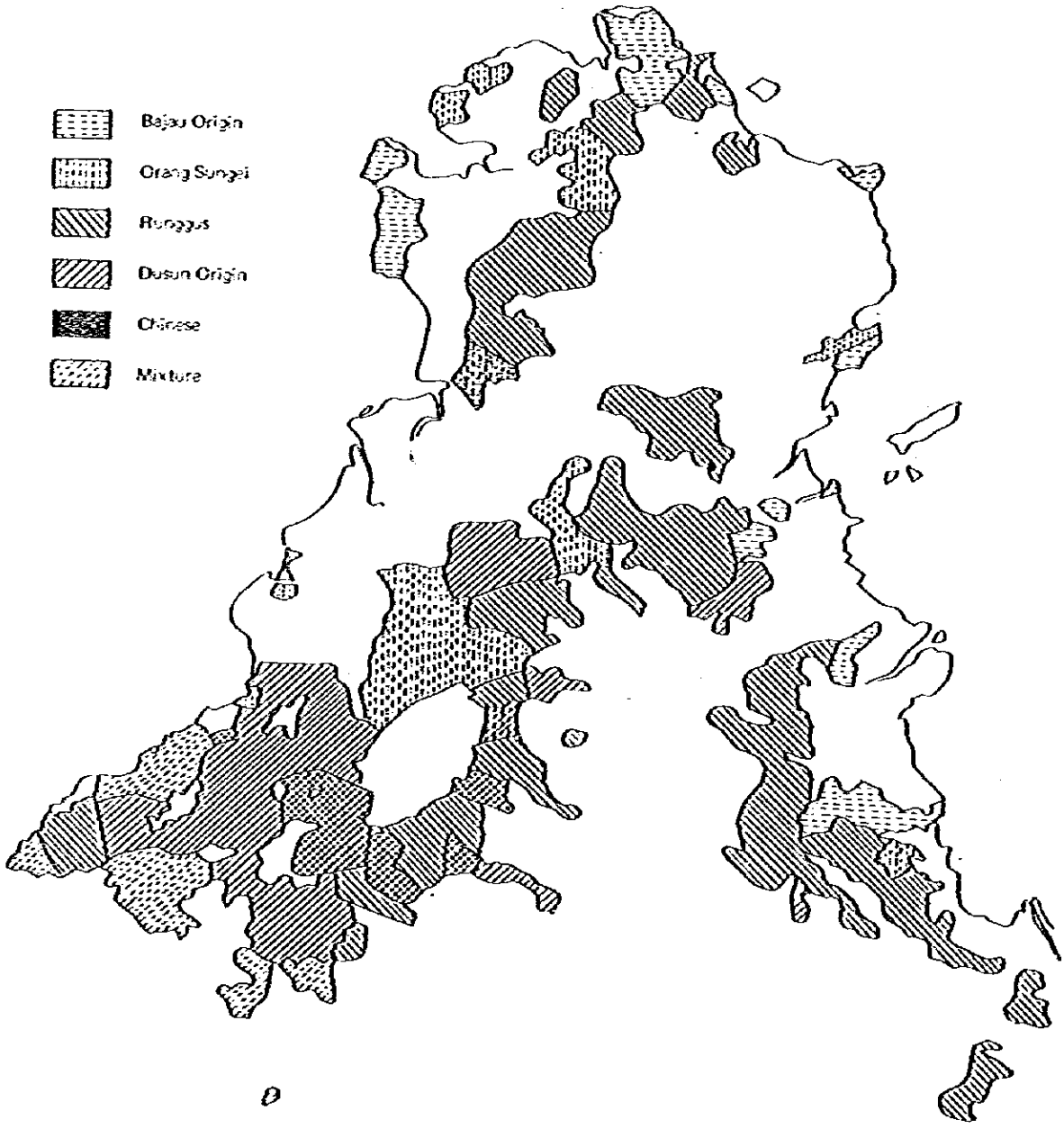
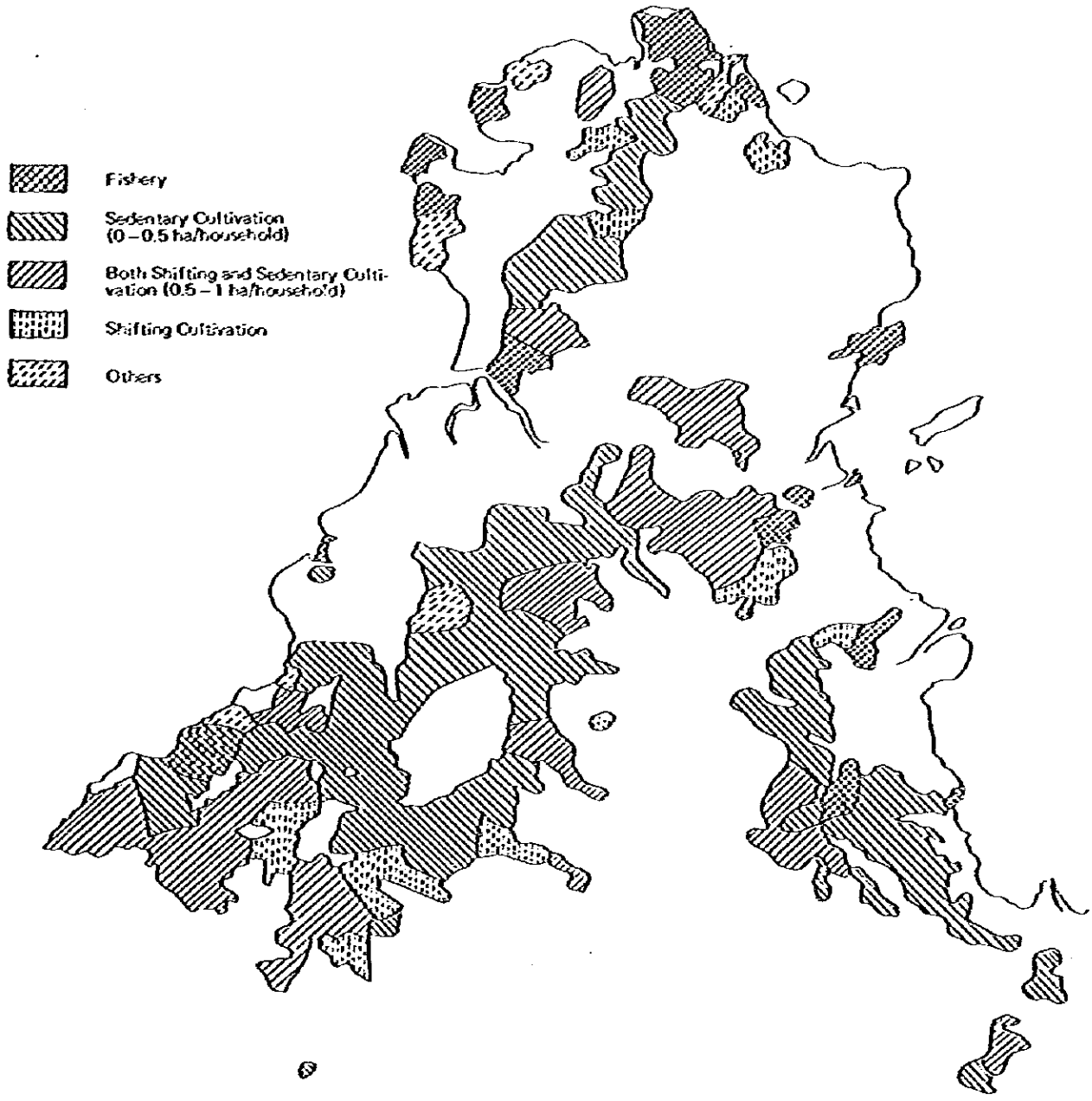


Figure 2-2 Distribution of Substantial Economic Activities



1,114 households, of which 1,001 (89.9%) are *Runggus*. The *Runggus* carry out both shifting and sedentary cultivation, making it difficult to clearly discern the difference between the two groups. If classification is made using the standard of the area under shifting cultivation being 1 ha per household, whereby local communities with an area of 1 ha or more on average are classified as shifting cultivation districts; and those local communities with an area of 0.5 1 ha are regarded as shifting and sedentary cultivation districts; and those with an area of 0.5 ha or less as sedentary cultivation districst; of the above-mentioned 43 local communities, 7 (16.3%) are dependent on shifting cultivation, 13 (30.2%) on both shifting and sedentary cultivation, 22 (51.2%) on sedentary cultivation, and one local communities (2.3%) on paid labor.

On average, the area under shifting cultivation is 0.51 ha per household, and the area under sedentary cultivation is 2.26 ha per household. Thus, although the number of local communities dependent on shifting cultivation alone is decreasing, this trend does not reduce the importance of shifting cultivation for the region. There are two reasons for this: firstly, shifting cultivation is still carried out in all districts, and secondly, the fact that about one quarter of the area under sedentary cultivation is used for shifting cultivation means that almost the same area as that under sedentary cultivation is burnt over only four crop rotations. Needless to say, shifting cultivation characterized by the inability to continuously use the land exerts a great influence on forests.

(c) Others

Tribes of *Dusun* origin such as the *Kadazan, Kimaragang, Tembanuoh* and *Sunsogon* live in the area from the boundary of Kota Maludu District on the east side of Bengkoka Peninsula to the upper reaches of the Bengkoka River. Their occupations are virtually the same as those of the *Runggus* tribe. There are also several Chinese living in the vicinity of Bongkol.

2-2-2 Outline of the Project Region

The project region encompasses 70 local communities, of which the *Runggus* comprise the majority with 1,016 households (55.0%), with the *Orange Sungei* having 276 (15.0%). The relationship between racial-linguistic groups and occupations show the same

trends as in Bengkoka Peninsula area: that is, there are a few tribes of the *Bajau* origin, and many communities are either dependent on shifting cultivation, or a combination of shifting and sedentary cultivation.

In terms of living standards, Bengkoka Peninsula has been the slowest region in Sabah State to develop. The region covered by the project has shown particular sluggish development, having a considerable number of poor households, which have scarce means of earning money.

o Agriculture

The rotation period for shifting cultivation has been rapidly reduced in recent years, although it is still 15-20 years in the highlands. Kendinga rice, tapioca, maize, yams, and sweet potato are the main crops. Many households in the area along the Bengkoka River near the Pitas market earn money from coconut cultivation. Most of the households breed chickens and hogs, providing them with animal protein but little income.

o Fishery

According to a 1973 survey, there are 330 fishermen, possessing 138 fishing boats, engaged exclusively in fishery. Only sixty-one of the one hundred and thirty eight boats were originally equipped with a four-horse-power outboard engine, but now almost all the boats have outboard engines. Many of the fishery households in the coastal area cultivate tapioca as a sidebusiness. The main catch is prawns, which had until recently been distributed in the Kudat market, but which are now sold to trawlers operating out of Sandakan.

o Commerce and Industry

Apart from small stores dealing in daily necessities and small-scale saw-mills there is nothing to be investigated.

o Public Utilities

In 1980, the Sabah Electricity Board constructed a 3 MW power station in the Pitas district to provide electricity to farming villages.

The residents now use rain and well water, but the government proposes to install a piped water supply in Pitas.

2-3 Significance and Objective of the Project

As already mentioned, great importance is attached to forests and forestry in Sabah State. However, they have been in relative decline in recent years.

It is therefore very timely that the Federal Government and the Sabah State have begun to lay the foundations for the introduction of systematic techniques for the conservation, sustained exploitation and development of forest resources.

The Bengkoka Afforestation and Settlement Project is innovative in Malaysia in terms of concept and approach. It aims at sustaining and cultivating forest resources and stabilizing settlers' life by involving them in forestry activities.

Quantitative and qualitative depletions in resources, as a result of selective cutting, should be regarded as a temporary phenomenon that can be recovered given enough time. Selective cutting should therefore be promoted as per the plan from the viewpoint of effective utilization of resources. On the other hand, the rotation period for shifting cultivation has been shortened, which will lead to the deterioration of forests and soil fertility, and finally to the breakdown of the shifting cultivators' life. The Afforestation and Settlement Project in Bengkoka, aiming to help the people escape from this vicious circle, is of great importance because it will become a good example of what is possible, not only for Sabah but also throughout Southeast Asia.

A survey carried out by helicopter made it clear that a considerable part of the Bengkoka Peninsula included in the project area has already been converted into grassland by repeated shifting cultivation, resulting in a reduction in the areas where settlement can be established. It may be said that the project was the best choice from the point of view of policy and strategy. It has also opened the way for the production of timber for the international market, the possible development of a wood processing industry, and the raising of income levels of the settlers. Such outcomes are very likely, because the wood processing industries of sawtimber, veneer and plywood are rapidly expanding. Moreover, in 1968 policies encouraging investment were embodied in several laws, including the Investment Incentives Act.

On the other hand, there are steep hills in the project region on the Bengkoka Peninsula, and there is also a danger of soil erosion following a decrease in forest area and in-

creases in grassland area.

Damage by forest fires was seen in the Project area during the field survey. From the stand-point of soil conservation, re/afforestation in this region is an urgent task.

The main tree species for the project is *Acacia mangium*, which has recently begun to be planted in Thailand, Malaysia, Brunei, the Philippines and so on. If the large-scale plantation of this species is successful and plays a pioneering role in introducing processing techniques, a great contribution can be said to have been made to re/afforestation in Southeast Asia. Possible tree species suitable for the Project will be discussed later in this report, but judging from the survey on existing man-made forests in Sabah, there are few problems in silvicultural techniques.

2-4 Administration and Management of the Project

As previously mentioned, forestry in Sabah still holds the greatest importance for the state's economy. However, because the proportion of logs in total exports fell from 40% in 1980 to 31% in 1983, and the proportion of commercial forests in the total forest reserves fell from 90% in 1977 to 81% in 1982.

Since earnings from forestry sector constitute a large proportion of state revenues, Sabah State adopted the policy to reduce log exports by half over the five years from 1977 in order to halt the decline in forest areas which had been predicted in the early 1970's. The policy also aimed at the commencement of a large-scale project for re/afforestation in order to sustain and cultivate forest resources. The State is making strenuous efforts especially in the introduction and cultivation of suitable species for plantation, and in the experimental research into the development and utilization of lesser-known natural tree species.

The government agencies of the Forest Department, the Sabah Foundation and SAFODA complement each other by carrying out their respective roles in the implementation of the forest policies.

The following is a description of SAFODA, which is in charge of the Bengkoka Afforestation and Settlement Project.

SAFODA is an organization set up under Enactment No.20 in 1976, with the objectives of encouraging facilitating stimulating, improving, adjusting, developing and managing forestry and re/afforestation, as well as performing related and incidental matters.

The activities of SAFODA involve:

- Converting waste and poor farm land into forest land;
- Promoting timber production from plantations and natural forests;
- Encouraging local people to actively cooperate in re/afforestation;
- Promoting settlement of inhabitants and the improvement in their living standards through agroforestry; and
- Raising employment by actively promoting the projects.

Figures 2-3, 2-4 and 2-5 are charts showing the organizational structure of SAFODA and other agencies involved in the project.

The Bengkoka Afforestation and Settlement Project began to be carried out at Division I in 1981. The forest road, nursery and settler housing programs of the first phase are now in the trial stage, while the power and water supply facilities have yet to be installed. To insure the steady and successful management of this project the following are required: a future reappraisal of the organization of the project, the continued availability of experts in nursery and re/afforestation, and adequate funds.

2-5 The Status of Division V

Division V is located in the Bengkoka basin in the southern extremity of the project region. It is bordered by the Paitan Forest Reserve to the east and northeast. The district has mostly low hills with the highest being 450m. The configuration of the division is the most complicated in the project region.

The soil in Division V is the most suitable for plantation in the region, judging from the soil and vegetation surveys.

Road traffic in the Bengkoka Peninsula is dependent on the ferry service across the Bengkoka River at Pitas. Previously there were only a few poor-quality dirt roads in the

Figure 2-3 Sabah Forestry Development Authority Present Organization and Staffing

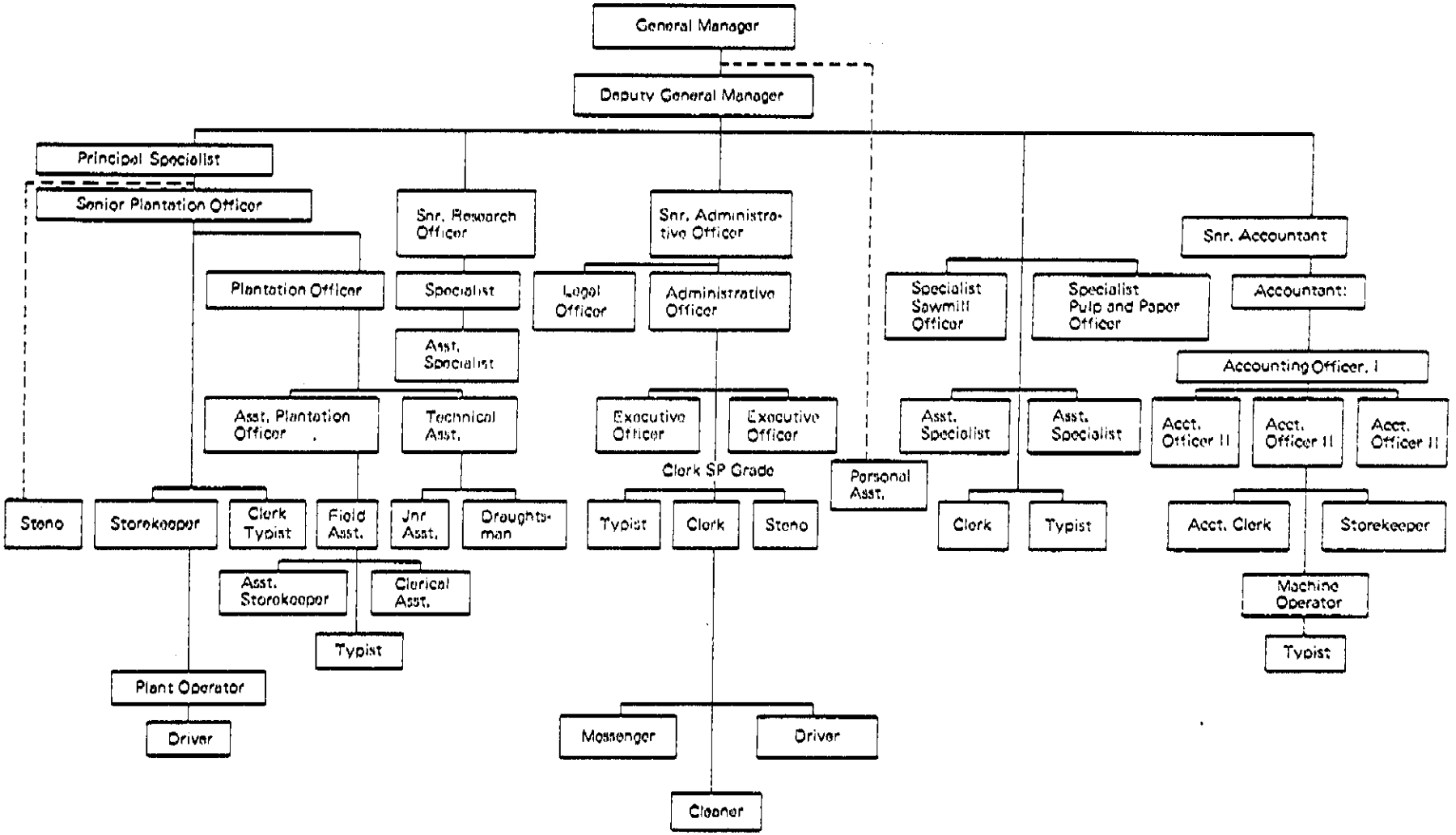
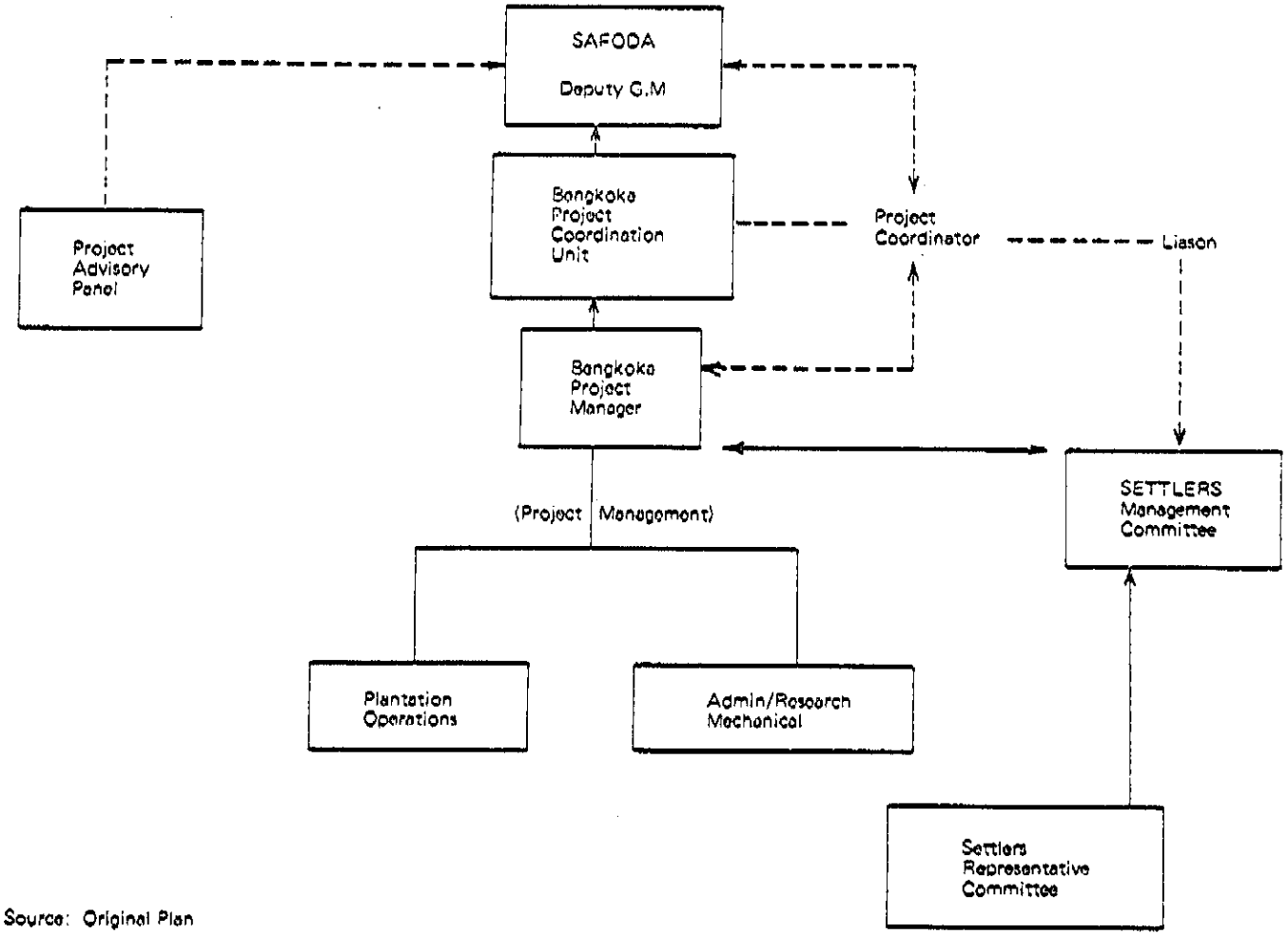


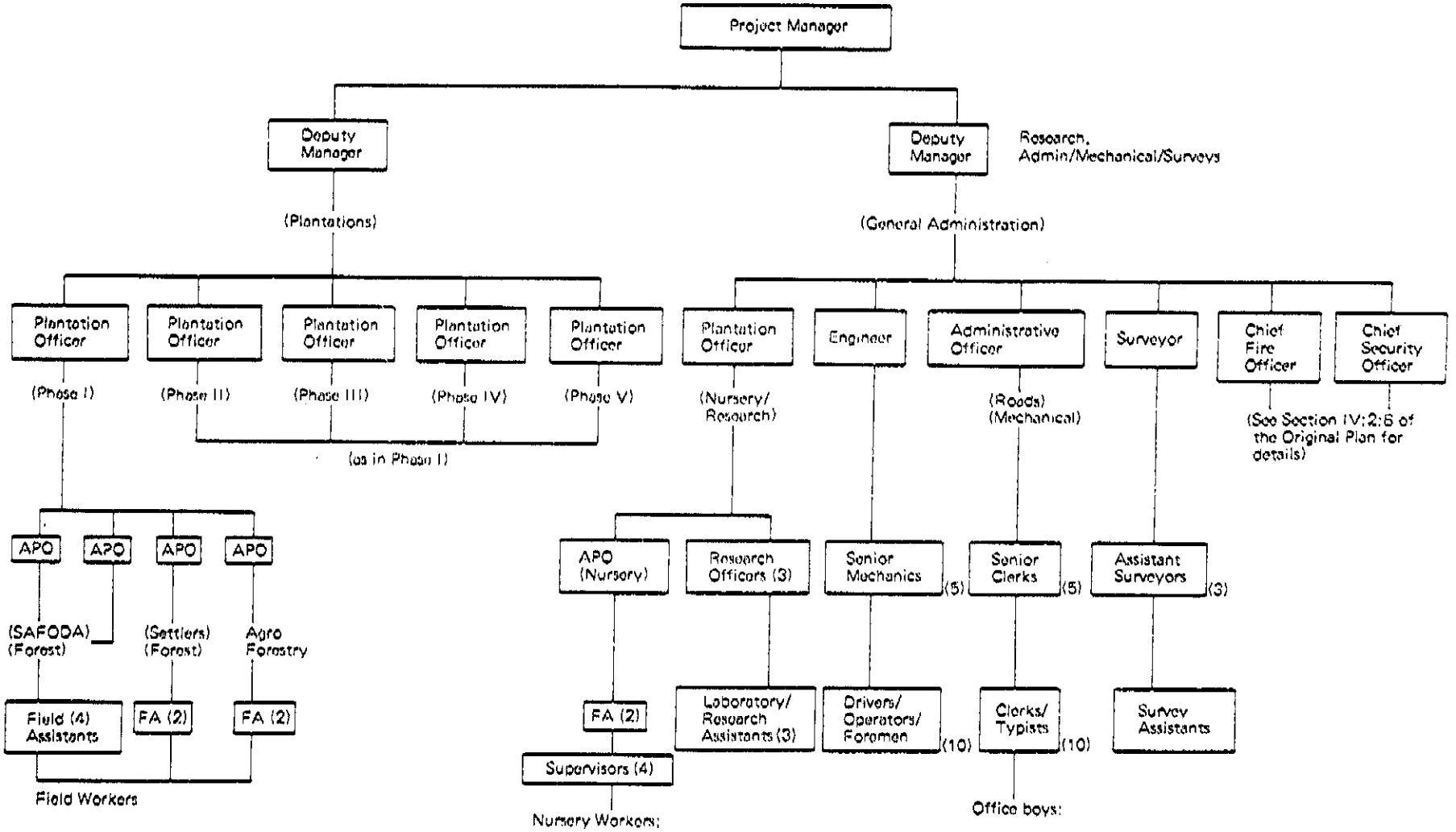
Figure 2-4 Bangkoka Afforestation Project:

Project Relationships



Source: Original Plan

Figure 2-5 Bangkoka Afforestation Project: Proposed Organization Structure



Source: Original Plan

Peninsula, but now there is a more extensive system of gravel and all-weather roads.

In terms of forest resources, there is little available exploitable timber in Division V, because the majority of the natural forests, as already mentioned, have been and still are being selectively logged and relogged. Because of this, there are many second-growth trees on either side of the Bengkoka River. Thus, forests in this district have been depleted in both quantity and quality; in addition, the economic value of natural forests has been reduced remarkably by forest fires throughout the Bengkoka Project region owing to unusually dry weather in 1983. The Division V has the highest potential productivity in the project region, since few places have been converted into grassland because of shifting cultivation.

3. Study on the Original Plan

3-1 Re/afforestation Plan

The important thing in drawing up an re/afforestation plan is to utilize the natural resources and seek multiple effects by harmonizing developed technology and the natural environment. To achieve this, however, we must determine to what extent silvicultural techniques developed in the study region will be established as productive technology, by tracing and recording accurately the results and experiences over a long period. The already commenced re/afforestation and settlement plan in Sabah began with very few silvicultural data because of the brief history of re/afforestation in Sabah. What is notable in the plan is that an exotic tree species, *Acacia mangium*, was chosen as the plantation species. Although the present study showed that this species grows very rapidly, most of the forests are only a few years old and silvicultural techniques, such as nursery practice, planting and maintenenance, have not yet been established as certified technology. On the other hand, even for species with a long history and well-established productive technology, experimental research and trial planting is still being regularly carried out to develop such techniques as spacing, weeding, pruning and thinning, as well as an integrated silvicultural system. It is difficult, therefore, to predict what will happen in the future in terms of the large-scale plantation of this exotic tree species with only a few years of development. For instance, there is no obvious solution for the technical problems of maintenance, protection (pruning, prevention against insects or diseases) processing or utilization.

Therefore, in this section, in order to accurately assess the re/afforestation program, we have looked at studies on the existing manmade forests in Sabah, and other literature. We have confined our remarks to the changes we considered necessary in the original plan.

3-1-1 Duration of the Project and Cycle of the Operation

The original plan set the cycle of operation at 18 years, dividing it into the following

three stages:

First stage :	6 years	Planting period
Second stage :	6 years	Tending and protecting period
Third stage :	6 years	Harvest period

Needless to say, the cycles cannot be so easily defined in reality. The planted area in the first year, for instance, should be tending and protected from the first year, and the first 6-year stage is the period of tending and protecting as well as the period of planting. This first planted area should also be reforested after being harvested in the beginning of the third stage, so the third stage is a planting period as well as a harvesting period.

There is no argument against the definitions of the terms, duration of the project or cycle of operation, but such a simplistic division as this is not only impractical but filled with the following managerial problems.

Firstly, if the planting is carried out according to this division in the second stage there will only be tending and protection and no planting; while in the third stage there will be harvesting, planting, tending and protection, causing an imbalance in the demand and supply of labor, leaving the nursery facilities unused for six years. The cost of maintaining the facilities also cannot be ignored.

Secondly, because cutting harvesting is concentrated in the 6 years of the third stage, management in and after the second cycle is expected to run into considerable problems. Although certain thinning yield can be expected, it is profitable only when carried out efficiently. Considering the marketability of a newly-introduced tree species such as *Acacia mangium*, it would be unwise to expect easy profits.

It is well-known that the policy of this project is to settle the local people in the region. Therefore, the above-mentioned problems not only constitute managerial problems, but also act against the social objectives of the project.

Next, we reviewed the final cutting age of *Acacia mangium* which is set as 12 years in the original plan. Some stands still showed a rapid growth in tree height and D.B.H. after 12 years.

Final cutting age should be decided according to management objectives. For instance, it can be determined by the time taken to produce maximum yield, or by the time it takes the most suitable tree size. However, in light of the management objectives it is not clear why the final cutting age in the original plan was fixed at 12 years.

In view of the above, the following revisions are proposed:

- In order to allocate labor as evenly as possible and to seek constant yield,

  $$\text{Planting area for each year} = \frac{\text{Total proposed area}}{\text{Final cutting age}}$$

- As for *Acacia mangium*, considering the diameter (over 30 centimeters) that is suitable for sawntimber, plywood veneer and furniture material, and its annual increment, the final age should be 15 years.

3-1-2 Planting Area

Based on the data obtained from aerial photographs, the general survey and the field survey of 15,000 hectares of Division V, the suitable area for afforestation was marked off on the map. The area was calculated at 9,000 hectares, representing the total extent of the planting area of the modified plan.

3-1-3 Tree Species for Planting

As reported in the original plan, *Acacia mangium* was introduced from Northern Queensland, Australia in 1966, and was first planted as a fire prevention forest in grassland areas. It has grown extremely fast, closing the tree crown in two years and covering the grass. Results of the experiments in grassland on alluvial soil showed that *Acacia mangium* grows well in poor soil. Accordingly, *Acacia mangium* was chosen as the tree species for the plantation.

When large-scale planting is carried out in areas with poor soil caused by shifting cultivation (such as in Bengkoka), its ability to grow rapidly in various soil conditions, comparatively high timber quality and strong marketability make *Acacia mangium* the best choice. Major tree species that have been planted in Sabah are *Paraserianthes falcataria, Eucalyptus deglupta, Gmelina arborea, Pinus caribaea* and *Acacia mangium*, but given the survey results in the existing plantations of these species, there is no doubt that *Acacia mangium* is the most suitable species for the large-scale plantation in Bengkoka.

However, as mentioned above, this species was introduced only recently and is yet to be recognized as a certified species for plantation, so it should be planted with other species, thereby avoiding large-scale plantations of solely one species. Therefore, in the modified plan we have chosen *Acacia mangium* as the major tree species, and it will be mixed at selected locations with other species e.g. *Paraserianthes falcataria* and *Gmelina arborea*.

3-1-4 Operation Methods

3-1-4-1 Weeding and Vine Cutting

The time and frequency of weeding should be considered to be interrelated. They should be determined in view of the weeding method, characteristics of the planted trees, weed ecology, labor and other economic conditions.

In the original plan weeding was done in the second, eighth, fourteenth, twentieth and thirty-second months after planting. However, the survey on *Acacia mangium* the existing plantations shows tree growth exceeding two meters within one year. We therefore assume the weeding in the original plan was too frequent.

In Division V especially, there is no lalang grassland, and weeds do not hinder tree growth, so after the second year this modified plan dispenses with weeding and requires only vine cutting.

The major vine plants are *Merremia peltata* and *Pueraria peltata*. Since the possibility that they hinder the growth of the planted trees is great, vine cutting should be done as part of the weeding after planting, and then two times as a separate operation: in the 12th, and 18th months after planting.

3-1-4-2 Improvement Cutting and Thinning

Though the time of improvement cutting slightly differs among tree species, site class and tending method, the first cutting is generally done when the tree crown closes, with the second occurring after two or three years. Improvement cutting is done to remove trees other than the proposed species but even these could be removed if they are inferior or stand too close together.

Since the purpose of thinning is to adjust the spacing to seek the maximum yield, in line with the production objectives, it is ideal to thin the necessary quantities frequently and then repeat these light thinnings. In practice, however, the extent of thinning depends on the intensiveness of the management.

The original plan requires 25 percent thinning of the existing trees in the fifth year and 33 percent in the eighth year. Considering that the growth of *Acacia mangium* is rapid, improvement cutting in the early stages is necessary and the rate should be increased.

According to the survey results of the existing man-made forests, three-year old *Acacia mangium* normally has a tree height of more than 10 meters and D.B.H. of over 10 centimeters; therefore, 40 percent of the cutting aimed at improving the plantation is necessary in the third year at the very latest. Therefore, two thinnings before the final cutting during the 15 years are desirable, but considering the intensiveness of the management, 20 percent of the existing trees should be thinned in the seventh year, and 25 percent in the eleventh year, reducing the tree number at the final cutting to 400 per hectare.

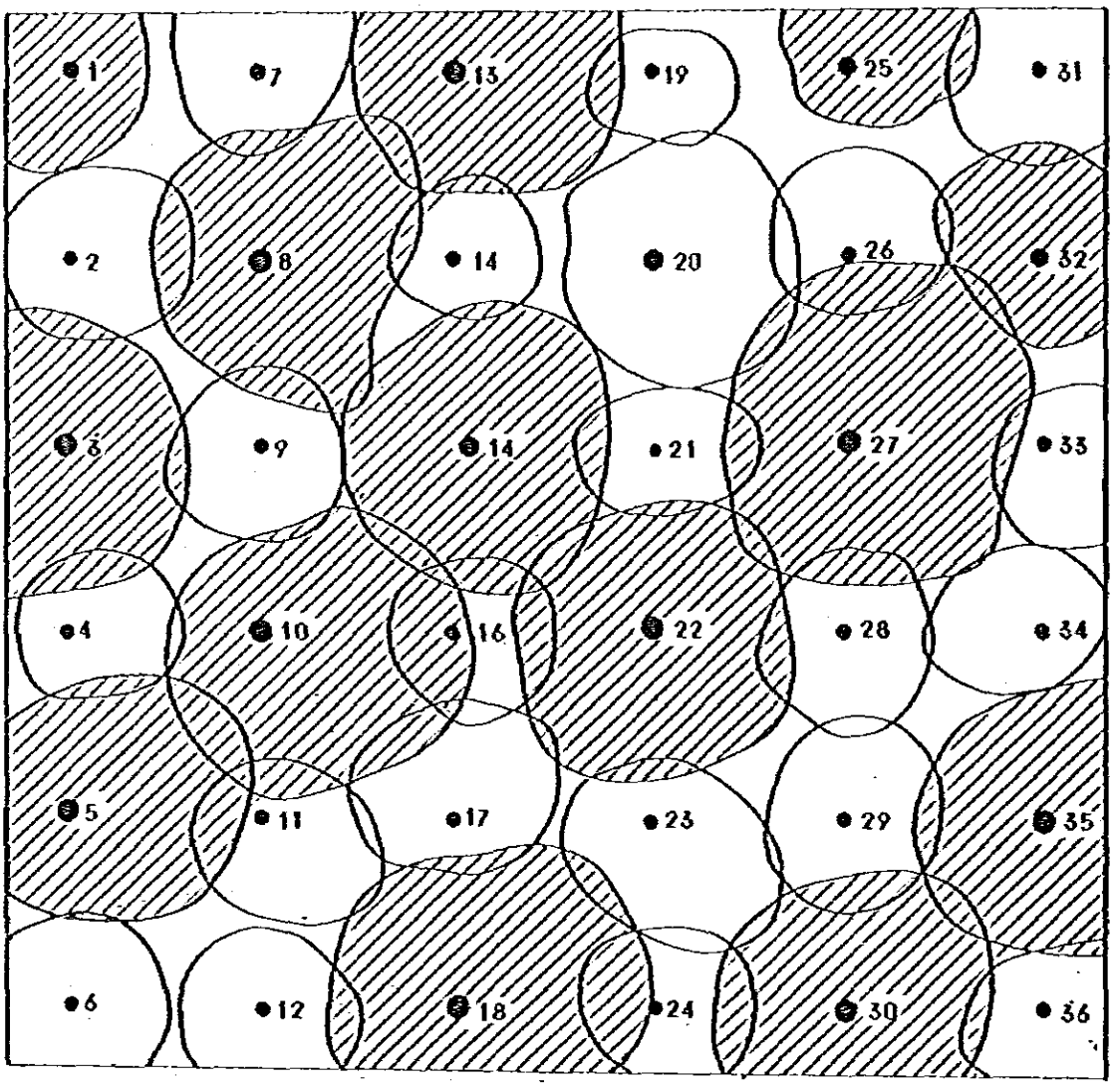
The actual number of trees at the time of final cutting has not been measured yet because no aged man-made forests exist. Therefore, drawings of tree crowns in several standard areas were made (shown in Figure 3-1), to test if the stands are adequately covered by the crowns of dominant trees which are needed to be alive until the final cutting. By this analysis, the average number of trees (400 per ha) showing the best condition was adopted as the final cutting figure.

3-1-4-3 Pruning

The most important thing in pruning is that the callus should be made from cambium around the cut section, with the cut section being covered before fungi invade. Though the ability to coalesce differs from species to species, the cut section coalesces early if the branch is small, if it is cut smoothly close to the trunk and if the tree's diameter growth is fast. The survey of the existing plantations shows that branches that die naturally were hardly to fall off, and rot affected the wood from the breaking point, thereby reducing the value of the timber.

To produce timber of high quality, it is desirable to frequently perform pruning. However, the frequency is determined in relation to how the timber is used in the production process, as well as the cost of the pruning.

Figure 3-1 A Sample of Tree Crown Drawings in a 4 Year-old Acacia Mangium Man-made Forest



Note: The marking (•) represents dominant trees needed to be alive at the first cutting age.

The original plan requires three prunings after plantings; in the twenty-sixth and thirty-second months and in the 6th year; the first pruning is done on all trees, the second for 25 percent of the trees, and the third for the dominant trees only. However, considering the utilization of *Acacia mangium*, the modified plan requires the prunings to be done after the improvement cutting in the third year, and in the sixth year.

3-1-4-4 Forest Fertilization

The original plan requires fertilization to be carried out seven times in the first four years after planting. It goes without saying that fertilization accelerates the growth of planted trees to produce timber with a shoter rotation. It was in the 1960s that forest fertilization became popular. Though the results have been positive fertilization was applied only when it was certain to raise profitability, or when trees are planted on poor soils for conservation purposes; it has seldom been practised with such intervals and operational scale.

Consequently, we cannot yet conclude whether it is advantageous from the management viewpoint to fertilize seven times over regular intervals. Compared with the other areas, Division V has no large area of grassland and, according to the soil survey, its soil is not poor; consequently the modified plan suggests that fertilization only be done at the time of planting to aid the growth and soundness of trees.

3-2 Nursery Program

3-2-1 Nursery Establishment

According to the original plan, a central and a satellite nursery will be established to provide seedlings needed for the re/afforestation project.

The central nursery will serve as the nursery operation center to supply all the seedlings needed for the re/afforestation project of Division I, and 50 percent of those needed for Divisions II-V. The original plan states that the central nursery and the satellite nursery are to readily provide the necessary quantities of seedlings so that they can be planted bet-

ween the end of the dry season and the beginning of the rainy season--the appropriate time for planting.

In contrast, the modified plan will be carried out in accordance with the ideas about nursery described in 4-2.

Accordingly, the nursery will be established to grow all the seedlings needed for Division V without depending on a central nursery. The reasons for this are:

- The nursery should be managed as an independent and self-supporting one.
- It is desirable that the nursery and the plantation area should have similar environmental conditions.
- The nursery and the plantation area should be geographically close.
- Effective utilization of labor in Division V can be achieved.
- It will be convenient to assess the actual conditions of local re/afforestation and feed back the results to improve the nursery techniques.

3-2-2 Nursery Operation

3-2-2-1 Seed Production

The original plan says that two-thirds of the seeds of *Acacia mangium* will be collected near Kota Belud and one-third in Sook (an inland area).

In future, however, seeds collected in the seed orchard by a mass selection method of breeding will be used.

Since it will be some time before seeds from the seed orchard can be used, the following temporary measure will be adopted.

- SAFODA will undertake to supply the best-quality seeds available from existing seed sources.
- As an alternative, the buying of superior-quality seeds from either the Forest Research Centre, Sandakan or Sabah Softwood Sdn.Bhd. should also be considered.

3-2-2-2 Seedling Production

The modified plan is not significantly different from the original one in regards to seedling production. It can be said that the production procedure is carefully planned, from collecting seeds, and sowing, to outplanting.

It will be difficult for some time to obtain, by breeding, seeds of good quality genes; consequently, healthy young seedlings will be selected when they are transplanted to pots from the sowing bed. Reselection will then be carried out at the time of outplanting to choose healthy seedings. In other words, healthy seedlings that show vigorous growth even in the early stage are outplanted.

The most important point to realize is the difficulty of selecting seedlings of good genes by this method, and the future careful procurement of seeds is an important task.

The nursery procedures of the original and modified plans are described in Figure 3-2.

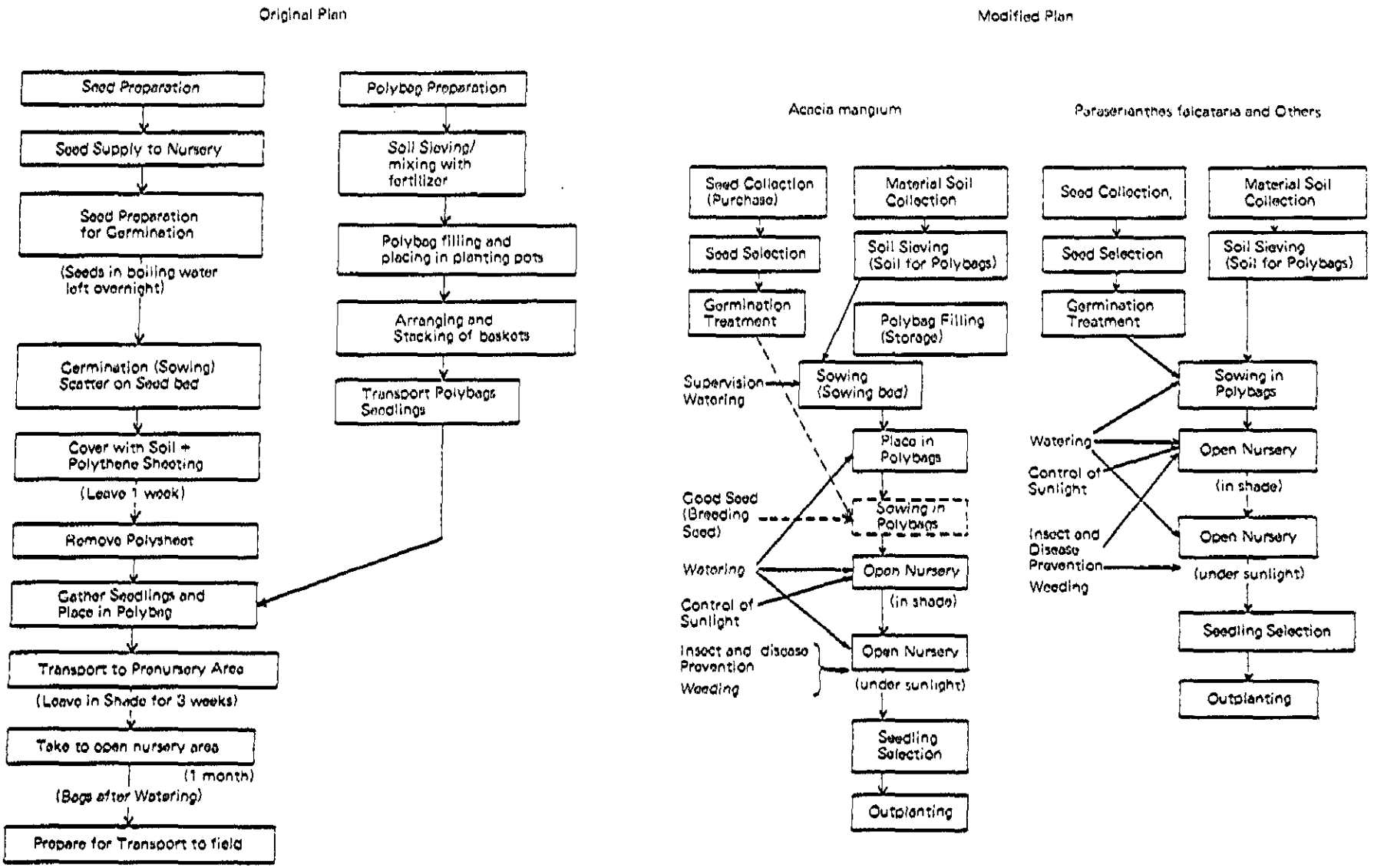
3-3 Settlement Plan

This project is, as mentioned previously in Section 2-3, an innovative project in terms of its policy, objectives and planning. The settlement plan can be said to be particularly valuable, seeking better welfare and happiness for the local people by raising their living standards. If this Project, combining re/afforestation and settlement, succeeds in the future, it will not only bring about great benefit to other parts of Southeast Asia that are similar to Bengkoka area, but will also provide valuable information for the already developed countries engaged in international cooperation.

However, the implementation of the original settlement plan by merely proceeding with a forest policy alone might create difficulties because the functions that forestry can fulfill are limited. To be successful, this forest policy should be integrated with the national land development policy.

Because there are difficulties in predicting the potential utilization and market price of *Acacia mangium*, the necessity of promoting such a comprehensive policy is emphasized before reviewing the settlement plan; although both the original and modified plans predict a bright future for this tree species, and profits to be earned as calculated in the original plan will likely be exceeded, the forecast is made only from the present perspective. Most forecasts use all available information and modern prediction methods to avoid discrepancies occurring between the forecast and the reality, but in fact a gap often appears between the two, forcing changes in, or suspension of, a project. Therefore, to successfully carry

Figure 3-2 Comparison of Nursery Procedure



out the original plan, the most reliable and safest methods should be adapted as and when applicable; and the settlement plan should desirably be set up in the policy framework within a broad perspective and high priority.

3-3-1 Base Location

The original plan locates the base of Division V at Sulakalong, but the field survey indicates that areas around the confluence of the Bengkoka River and the Mandamai River [that is, the area from the village of Pandang-Mandamai to the opposite river bank of Kobon (see Figure 3-3)] are more suitable. The reasons for this are:

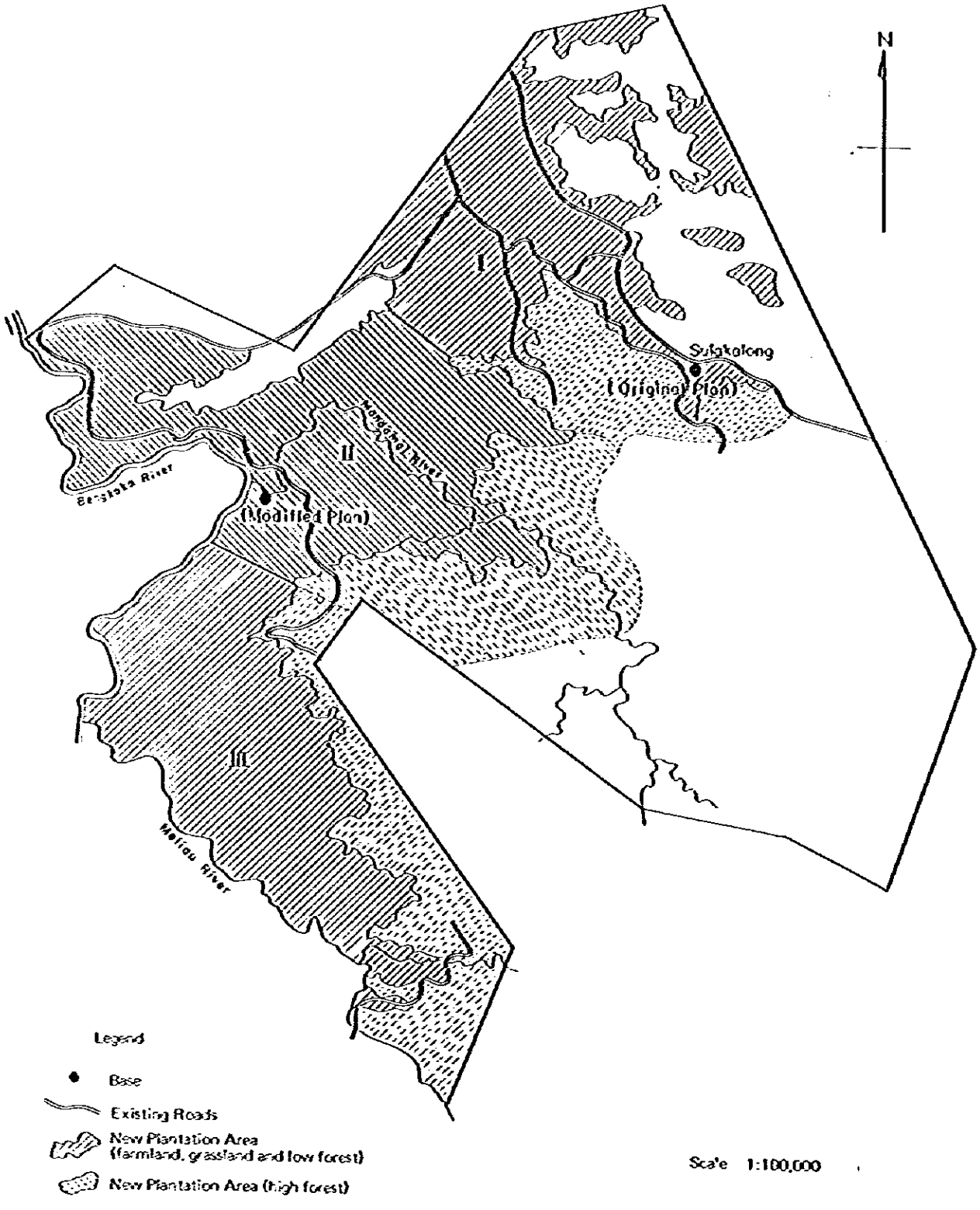
- The area faces the Bengkoka River, which has abundant water, making it easy to secure water that is indispensable for the life of the local residents and the nursery.
- The area is only three kilometers from the road that runs between Pitas and Dandon.
- The gently-sloping hills are suitable sites for the installation of various facilities.
- It is situated almost in the center of Division V.

3-3-2 Stability and Improvement of Life

The following measures of the original plan aim to stabilize and improve the life of the local residents:

- Four hundred households of shifting cultivators that are living in the project area and its vicinities will be settled.
- By participating in the re/afforestation project settlers will obtain wages and stabilize their livelihood.
- Each settler household will be given 15 acres (6.07 hectares) of land for tree plantation which will be the basis of their income.
- Each household will be provided a house equipped with electricity and water with 0.1 hectares of land.
- Settlers, as well as the project staff, can use the community center, school, clinic and recreation facilities.
- In the third year after settling, at least 200 hectares of farmland will be provided to settlers with appropriate guidance.

Figure 3-3 Location of the Division V Base



The policy aims at securing income for the residents in the project area and its vicinities by providing job opportunities through the re/afforestation and harvest operations, and to stabilize and improve their life by establishing the foundations of their basic living environment.

As mentioned previously, the policy is, in general, a good one, but certain measures need reviewing. SAFODA itself studied the original plan and concluded that some changes were necessary. Income from work in the forests is regarded as the most important consideration of all, and the ways to distribute income to settlers were changed as follows:

In the original plan, two-thirds of the forest yield will go to SAFODA and one-third to settlers. From the settlers' viewpoint, the following are the most important aspects of the plan:

- A forest area including ownership rights, of 15 acres (6.07 hectares), will be given to each settling household.
- Settlers will maintain their own area from the fourth year after planting and in the forests owned by SAFODA they will be paid for the forestry work they perform.
- Settlers will receive an income at the time of harvest of the man-made forests, after deducting expenses for their land, housing and other facilities.

Upon studying, SAFODA changed the plan in the following ways:

- Settlers will not be given ownership of the 15 acres (6.07 hectares) forest land.
- Settlers will receive a share of 1 acre (0.40 hectares) by working at least 150 days in one year. Therefore, during 15 years of rotation, the total share will not exceed 15 acres (6.07 hectares).
- At the time of harvest, settlers will be guaranteed the income from their shares.

After reviewing the SAFODA plan, the following suggestion would be suitable for the project:

- It is proper that the shares of settlers be based on the number of working days in a year, but the number fluctuates depending on the schedule of operations. Therefore, "yearly working days" should be changed to "percentage of actual working days in the total number of working days in a year, designated by the operation manager". (For example, settlers who worked more than 70 percent of the yearly working days.)

o Regarding the calculation of shares at harvest time, each settler's share of the previous 15 years constitutes the number of his shares, and one-third of the total profit will be divided according to the number of shares of each settler. The reason for this change is that according to the original plan, a person who move out of the settlement after receiving his share still hold the rights, further, adding to the shares of new settlers, the total will exceed 6,000 shares (15 × 400 persons). The system has been adopted to prevent this, and also to clarify the way of handling the shares which settlers, who worked less than the requested working days a year, lost the right to hold.

3-4 Administration and Management

The management and organizational structure for SAFODA and the Bengkoka Afforestation and Settlement Project of the original plan has previously been mentioned (See Section 2-4, The Administration, and Management of the Project).

In the modified plan, the Division V Administration Office will be set up under the General Manager of SAFODA. Figure 3-4 shows the organizational structure. For the sake of more effective administration and management, a technical adviser will be employed.

The reasons to set up the Division V Administration Office as an independent organization are:

o To strengthen the responsibilities of the office
o To carry out the project in line with the local conditions
o To develop good plantations by effective guidance and supervision
o To fully utilize the labor force by having close communication between staff and labor
o To advance the development of the local community
o To establish excellent man-made forests through the activities of the Silviculture Research Institute.

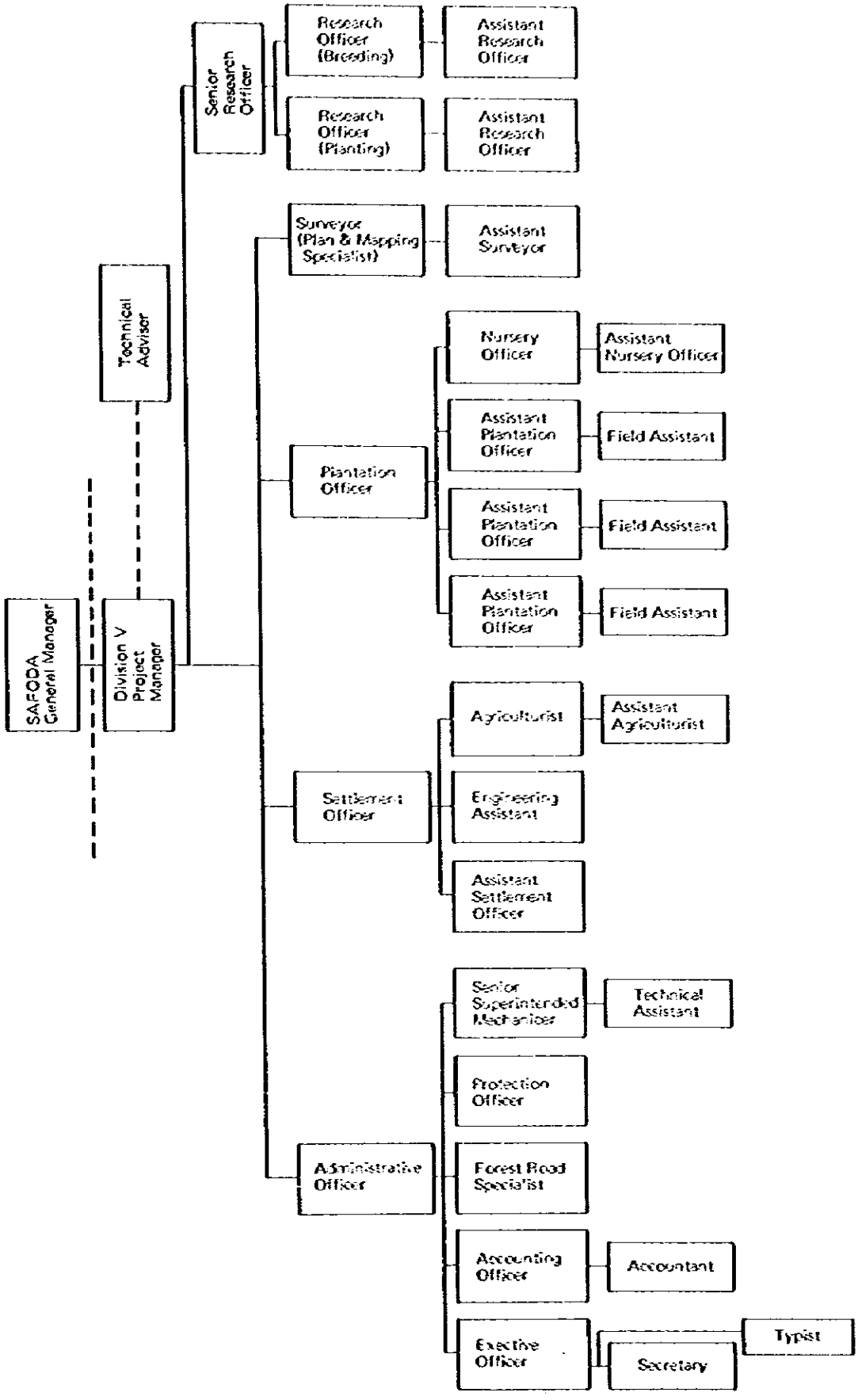


Figure 3-4 The Organization Chart of Division V Administration Office

3-5 Financial and Economic Analyses

A large-scale public project like the Bengkoka Afforestation and Settlement Project requires economic analysis to analyze the extent to which the project is essential from the national point of view, as well as financial analysis to analyze the amount of investment required in the project and the amount of revenue likely to be accrued.

The original plan examines the feasibility of planting *Acacia mangium* in terms of an implementation plan. Moreover, an economic assessment of the whole project is undertaken, by looking at the profitability of the project itself, and the income and expenditure of settlers and SAFODA. Unlike the small-scale re/afforestation operations scattered about the central area of the West Coast District of Sabah, the re/afforestation work in this project is a large-scale commercial operation covering the whole of the Bengkoka Peninsula. In this sense, the profitability of such operations must be thoroughly examined.

On the other hand, the settlement project is of the public investment type with a strong emphasis on income redistribution. It aims at providing employment opportunities for the local people (at present, one of the poorest in the Federation) through re/afforestation, and at raising the living standards by providing at least the minimum infrastructure for a satisfactory living environment.

In most cases, the public investment-type project cannot be expected to produce direct income, or, if at all, very limited income, to fail to cover the costs. This type of project is not designed to garner direct income from the operations, but rather to achieve indirect economic benefits that will contribute to the betterment of the whole country.

The Bengkoka Afforestation and Settlement Project is innovative in the sense that it will be able to cover the costs of social overhead capital with profits made from re/afforestation project. The criterion of financial analysis is profitability, and it has to be judged whether the sales income accruing from the re/afforestation will be sufficient to defray the costs of plantation work and the social overhead capital when the project is implemented.

Although the project can pay enough, income will accrue in the future, and it takes a long time to complete the cycle from capital investment to harvesting, especially in the case of forestry. If it is financed by the government during the period, there will be competition with many other projects for the allotment of government funds. Accordingly, the ex-

amination of expenditure and the plan for necessary funds have to be very discreetly made. Reviewing the original plan in these terms, the financial analysis procedure is generally considered to be correct. The same procedure was applied to the financial analysis of the modified plan.

However, careful consideration should be given to the following:

- Some time has passed since the formulation of the original plan, and some changes have been made in the original plan.
- While the original plan is concerned with the whole project, the analytic survey in this modified plan is confined to Division V. Although the Division V project is independent of the other Divisions, the outlays and revenues are not necessarily one fifth of the total because there are differences in terrain etc.
- Since the details of Division V were not determined at the time of the drawing up of the original plan, the outlays involved in Division V only were not detailed.
- In the original plan, public facility rates and related charges will be shared between SAFODA and the settlers. The collection of charges from settlers should be fully discussed, and it is safe to determine that SAFODA will bear them as a rule at this stage.
- While the assessment period is short in the original plan, the cycle of forestry from planting to harvesting is long. In the Bengkoka Afforestation and Settlement Project, the survey recommends the fast growing *Acacia mangium* species, which requires a period of 15 years before it can be harvested. Therefore, the initial investment will hardly be recovered with the first harvest alone. In the original plan revenue estimates were overly optimistic, and if they are adjusted, the project would become impossible in terms of the original period of assessment.
- The outlays that were estimated in the original plan were calculated in real prices. However, when the government offers grants, they are generally paid annually at nominal prices. For this reason, the conversion to nominal prices may be necessary when calculating both revenue and expenditure.
- In the original plan the cost of financing is not included in the overall cost.

In this connection, almost no economic analysis has been made in the original plan from the point of view of national economy. Besides difficulties in methodology this is probably because the original plan has started from the point where the purpose of project was already given as a premise.

4. Forest Working Plan

4-1 Re/afforestation

4-1-1 Planting Area

The following points were taken into consideration in determining the planting area of 9,000 hectares.

- The natural high forest is a logged-over area. Although large- and medium-size trees still remain there, the afforestation area with an inclination of less than 15 degrees was considered the suitable area for new plantation. The remaining trees on the planting area are to be utilized as material for charcoal production.
- Marsh areas that are likely to be inferior man-made forests in the future were excluded.
- The total areas for the forest roads, firebreaks, nurseries and other facilities must be deducted from the total planting area.
- In order to clearly define the location of the planting area, and to facilitate the planning and operation of works, the plantation area in Division V will be divided into three areas as shown in Figure 3-3: I. Kibulu Parcel (Sulakalong), II. Mandamai River Parcel, and III. Meliau River Parcel.

4-1-2 Land Preparation

Considering the survival and growth of planted trees and efficiency of operation, Sabah has adopted land preparation by the most effective method, namely, burning. The modified plan also uses this method. In view of past results the following points should be incorporated into the plan.

- Slashing and burning will be done from the beginning of June to the end of October, so that planting can be carried out during the rainy season from November to February.
- Slashed plants should be well dried.

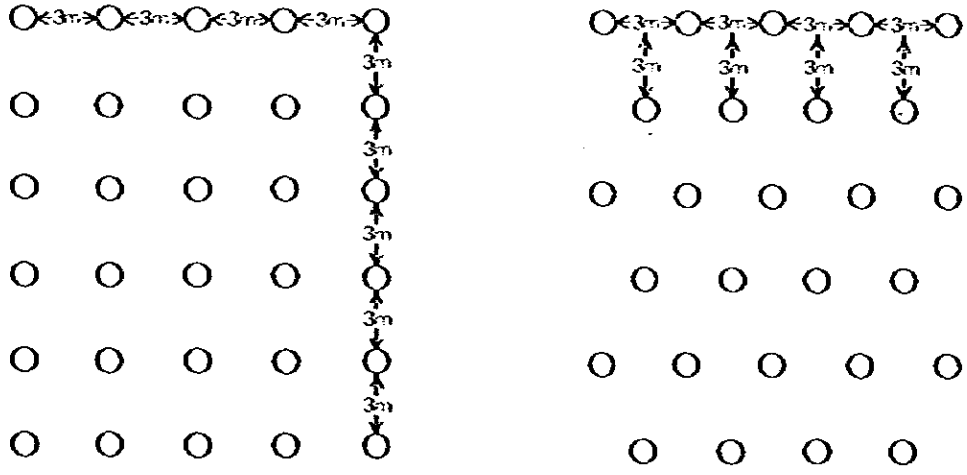
- We will prevent the possibility of fire from spreading to adjoining areas by making fire breaks, and plowing the ground along the boundaries of the burning areas.
- Before commencing burning, fire fighting units should be on the stand-by in the case of emergency.
- The most efficient way should be devised for slashing, using a combination of chain-saws, bush cutters and manual labor.
- The remaining trees in the natural high forest are felled to be utilized as material for charcoal production; then land preparation will be undertaken.

4-1-3 Planting

4-1-3-1 Number of Seedlings to be Planted

The number of *Acacia mangium* seedlings to be planted in Sabah is 1,110 per hectare (3m × 3m). Judging from the growth conditions in the existing man-made forests, it appears that the number of stems/ha can be varied, depending on the quality of the topography and soil conditions, in order to obtain early canopy closure. Where conditions are good the number can be reduced, but where they are poor the number may be increased. Changes in the number of stems/ha may affect the timing of thinnings. Compared with

Figure 4-1 Methods of Planting



existing man-made forest, topography and soil conditions of Division V can be considered to be medium, the modified plan sets the number of seedlings at 1,110 per hectare (3m × 3m). When the tree spacing is 3m × 3m, there are two ways of planting, as indicated in Figure 4-1. There is no interrelation between the method of planting and growth of the trees, but square planting is more convenient for removing and transporting thinned trees.

4-1-3-2 Planting Holes

The original plan requires planting holes of 3 inches (7.5 centimeters) in diameter and 9 inches (23 centimeters) in depth. Judging from the survival and growth conditions in the existing manmade forests, this size is considered to be adequate. The following points should be taken into consideration.

- Care should be taken so that there will be no possibility of soil erosion due to rainfall.
- In areas of hard soil, e.g., grassland or critical land, planting holes should be larger than normal.

4-1-4 Weeding and Vine Cutting

As mentioned in Section 3-1-4-1, the modified plan requires weeding and vine cutting. In carrying out the work, the following points should be taken into consideration.

- Care should be taken so that planted trees are not damaged by weeding and vine cutting works.
- Weeding (together with vine cutting) is done in the second, fifth and eighth months after planting; vine cutting is done in the twelfth and the eighteenth months thereafter.
- If weeding and vine cutting are behind schedule, the growth of the planted trees will be extremely hindered; therefore, attention should be paid to the growth of the underbrush to have the work completed in time.

4-1-5 Fertilizing

The original plan requires 4 ounces (113 grammes) of rock phosphate to be put in the planting holes at the time of planting. As fertilization at the time of planting is extremely

effective, the modified plan also requires fertilizing at this time (Principles of Fertilizing are discussed in 3-1-3-4).

4-1-6 Improvement Cutting and Thinning

In the modified plan improvement cutting and thinning are undertaken as mentioned in Section 3-1-4-2.

Although the cutting percentage is predetermined it is often difficult even for a person experienced to choose the right trees to be cut. However, the following two methods are commonly used.

- o Qualitative thinning

  The method in which the types of tree to be cut are predetermined, so that the quantity of trees to be cut is established.

- o Quantitative thinning

  The method in which the quantity of the trees to be cut is predetermined, before the kinds of tree to be cut are determined.

So far actual thinning operations in Sabah have been very few, so in doing the work we will stress on choosing the trees that should remain. The following points should be taken into consideration;

- o Weak trees susceptible to insects or diseases should be removed if necessary;
- o If the trees are thinned to excess, branches may grow too fast, resulting in knotty tapering trees; therefore, the distance between the trees should be kept even;
- o In forests with fertile soil a few more trees should be selected for cutting, and when the soil is poor, a slightly smaller number should be selected.
- o Before selecting the trees to be cut, a trial stand should be set aside where experimental cutting can be carried out, and the data should be recorded.

4-1-7 Pruning

In the modified plan pruning is carried out as mentioned in Section 3-1-4-3. The following points should be taken into consideration.

- The first pruning is done up to one-third of the tree height, and the second up to the suitable height above the ground.
- Branches that are considered to greatly act on the growth of planted trees are left.
- Although pruning is normally done on branches which are below the biggest branches and which will not affect the growth of the trunk, determining which are the biggest branches is difficult; therefore, care should be taken so that not too many branches are pruned.
- Trees considered to be thinned in the next time do not need pruning, unless their branches hinder the growth of nearby trees.
- To prevent fungi damage coal tar may be applied, but as some kinds of coating chemical slow the recovering of cut sections or do harm, care should be taken.

4-1-8 Scope and Timing of Re/afforestation Works

The scopes and suitable time of re/afforestation works in the original and modified plans are described in Table 4-1 and Figure 4-2.

4-1-9 Facilities Necessary for Re/afforestation

Buildings and vehicles required in the re/afforestation works are described as follows:

(1) Buildings

- Plantation office

The plantation office will be built next to the administration office of Division V. The wooden, one storey house will be equipped with office machines.

- Warehouse

A wooden, one-storey warehouse will adjoin the office and be adequate for the storage of the planting equipment.

- Garage

The plain, wooden, one-storey garage will house vehicles.

- Field office

The field office will be a wooden one-storey facility used as a base for supervising

Table 4-1 Scope of Re/afforestation Works

Item	Original plan	Modified plan	Remarks
Total plantation area (F)	7,287 ha	9,000 ha	
Annual planting area	$\frac{7,287\ ha}{4}$ = 1,822 ha	$\frac{F}{U} = \frac{9,000\ ha}{15}$ = 600 ha	
Final cutting age (U)	12 years	15 years	
Three species for plantation	Acacia mangium	Acacia mangium Paraserianthes falcataria Gmelina arborea	
Land preparation	Burning	Burning	
Planting	1,075 per ha	1,110 per ha	
Spacing	(10 x 10 feet)	(3 x 3 meters)	
Weeding	Five times: 2nd, 8th, 14th, 20th, 32nd month after planting	Three times: 2nd, 5th, 8th month after planting	Weeding included vine cutting Weeding in the 20th, 32nd month is done if necessary.
Vine cutting	–	Twice: 12th, 18th month after planting	
Fertilizing	Seven times: At planting time, 2nd, 8th, 14th, 20th, 32nd month, 4th year	Once: At planting	
Supplementary	2nd month, 15% (160 per ha)	2nd month, 10% (110 per ha)	
Pruning	Three times: 1) 26th month, 1/3 of tree height 2) 32nd month, 1/3 of tree height 3) 6th year	Twice: 1) 3rd year (after clearing), 1/3 of tree height 2) 6th year, up to the suitable height above the ground	
Improvement cutting	–	Twice: 1) 18th month: 2) 3rd year, 40% of the tree total	
Thinning	Twice: 1) 5th year, 25% of the tree total 2) 8th year, 33% of the tree total	Twice: 1) 7th year, 20% of the tree total 2) 11th year, 25% of the tree total	
Tree total at the final cutting age	494 per ha	400 per ha	
Protection against insect and disease	Chemical spray after 5 years	Chemical spray in the case of insects and diseases	

the field operations, as the workers' restplace, and temporary storage of equipment for field works.

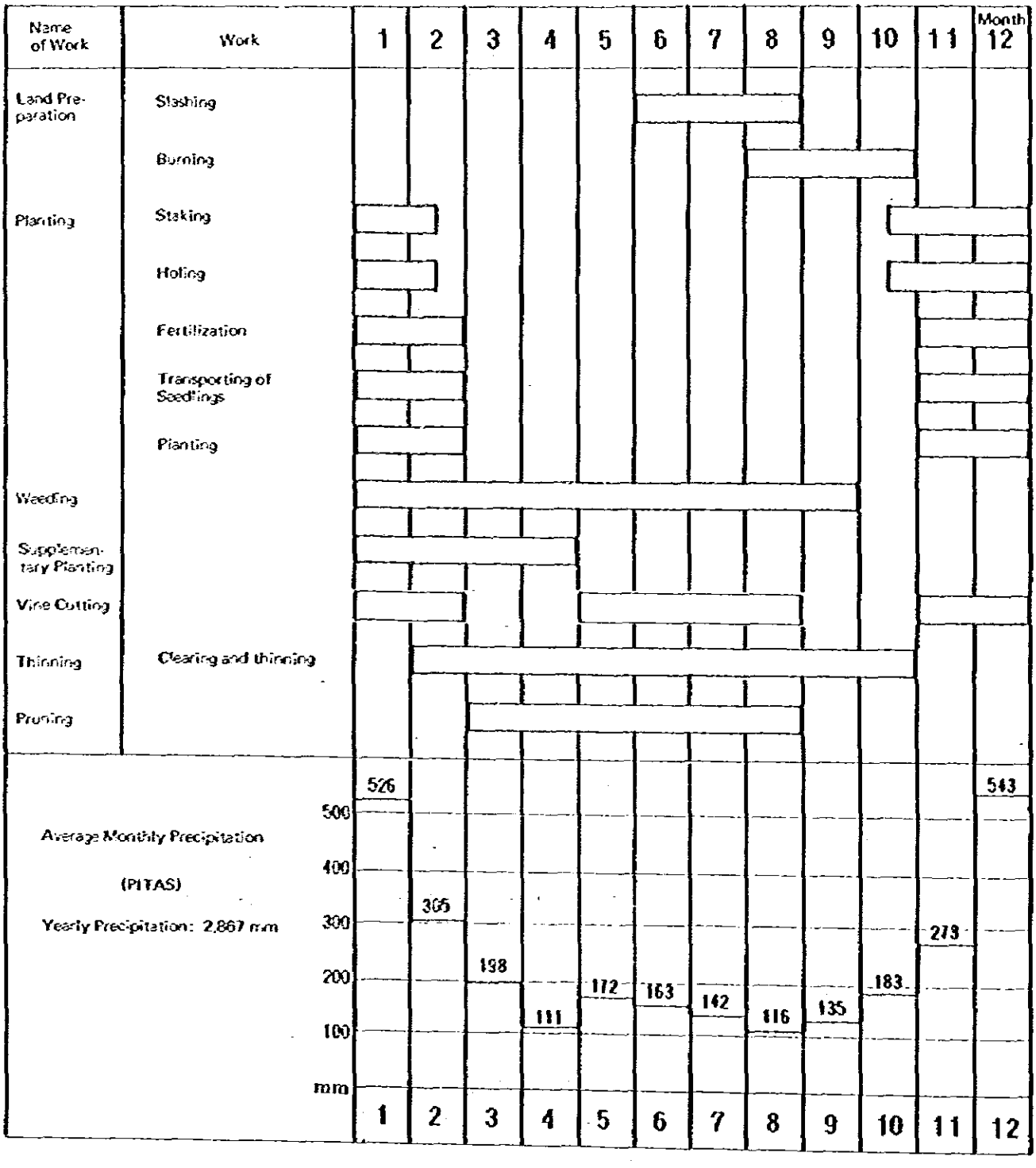
(2) Vehicles

The modified plan requires the provision of the following vehicles:

Trucks	4WD, 4 tons	3 units
Tactors	Wheel type	3 units
Wagons	4WD	4 units

Duration shall be five years.

Figure 4-2 Timing of Re/afforestation Works



4-2 Nursery Operation

The purpose of the nursery is to efficiently produce good seedlings. The seedlings must be of suitable size for outplanting, have genes that enable vigorous growth.

For good seedlings to be produced, the conditions for the nursery fields have to be satisfied, and the nursery has to be maintained by efficient workers under the guidance of specialists.

Fundamentals for operating the nursery will be described below.

4-2-1 Establishment of Nursery

4-2-1-1 Nursery Site

(a) Principles

- Seedlings required for the re/afforestation project of Division V are to be produced in the nursery in Division V;
- The production capacity will be sufficient to supply the maximum amount of seedlings required;
- The establishment of nursery and the production of seedlings are to be efficiently managed to reduce production costs;
- Fixed nursery will be used. The nursery lots will be as flat as possible; and
- Nursery will be located near the residential area of Division V.

(b) Criteria for Selecting the Nursery Site

- Environmental conditions of the nursery should be similar to those of the re/afforestation site;
- Supervisors should be able to manage the nursery sufficiently;
- The distance between the nursery and the re/afforestation site should be reasonable;
- Material soil for potting should be easily obtained;
- Adequate water supplies for watering;
- Nursery should not flood during the rainy season nor should the water rise;
- The area necessary for seedling production should be reserved; and
- The required labor should be available.

To satisfy these conditions, the flat land located on the right side of the junction of upper area of the Bengkoka with the Mandamai has been selected. This area is the proposed site of Division V Management Block.

4-2-1-2 The Scale of the Nursery

Seedlings will be produced by using pots. The nursery period is to be four months on average, so that the plants may be supplied in time for outplanting. Based on these standards, the scale of the site has been set at 12,000 m² (Table 4-3), in line with the seedling production plan (Table 4-2) of the re/afforestation project.

4-2-1-3 Nursery Facilities

(a) The Establishment of the Site

The establishment of the site begins with the clearing of bushes, followed by measuring and sub-dividing the site according to the different uses for each section.

Facilities will be constructed when the ground leveling of each section by bulldozer is completed according to these different uses.

(b) Nursery Facilities

- Nursery Lot

  The nursery lot will be divided into several blocks by passages, near which simple ditches will be dug for drainage. In the lot, nursery beds for potted seedlings will constructed.

- Sowing Beds

  Sowing beds will be made of wooden frames 15 cm deep, filled with prepared material soil up to 10 cm. Attached to the workshop, it will have a roof to protect it from rain and direct sunlight.

- Nursery Beds for Potted Seedlings

  After ground leveling, frames made of straight logs or square bars 4 cm in diameter will be laid out to frame the bed in the lot.

  It is advisable that vinyl sheets should be spread on the ground to stabilize soil, to prevent weeds from overrunning and roots inside the pots from intruding into the ground.

Table 4-2 Seedling Production Schedule

Year	Re/afforestation area (ha)	Tree species	Number of seedlings produced	Number of outplanted seedlings	Remarks
2	240	Acacia mangium	366,300	293,040	1,110 seedlings/ha, recovery rate of seedling: 80%
	60	Paraserianthes falcataria, others	91,575	73,260	do
Total	300		457,875	366,300	
3	480	Acacia mangium	732,600	586,080	
	120	Paraserianthes falcataria, others	183,150	146,520	do
Total	600		915,750	732,600	
4	480	Acacia mangium	732,600	586,080	
	120	Paraserianthes falcataria, others	183,150	146,520	do
Total	600		915,750	732,600	
(		The same as above for each year			
15	480	Acacia mangium	732,600	586,080	
	120	Paraserianthes falcataria, others	183,150	146,520	do
Total	600		915,750	732,600	
16	480	Acacia mangium	732,600	586,080	
	120	Paraserianthes falcataria, others	183,150	146,520	do
Total	600		915,750	732,600	
17	240	Acacia mangium	366,300	293,040	
	60	Paraserianthes falcataria, others	91,575	73,260	do
Total	300		457,875	366,300	Including supplementary planting
Grand total	7,200	Acacia mangium	10,989,000	8,791,200	
	1,800	Paraserianthes falcataria, others	2,747,250	2,197,800	
	9,000		13,736,250	10,989,000	

Table 4-3 Required Area for Nursery

(m²)

Sites	Area	Remarks
Nursery lot	3,600	Two annual rotations, 400 seedlings/m², including passages
Attached building site	4,400	Office, workshop, warehouse, garage, etc.
Protection tree belt and reserves	4,000	
Total	12,000	

In order to keep potted seedlings upright, 5 cm wire meshes will be set up over them. (The reason for choosing 5 cm meshes are that pots 4.5 cm in diameter are used.)

o Shading Facilities

The nursery beds for potted seedlings are to be equipped with shading facilities using logs or square bars 5-6 cm in diameter to facilitate the growth of small seedlings. Shadecloth will be used as shade.

o Watering Facilities

As the seedlings grow in pots, watering is very important, and will be done by bringing water under pressure from a water tank.

As a water source, the streams of the Bengkoka will be pumped into the tank.

(c) Buildings

o Nursery Office

A Nursery office will be a one-storey wooden structure with a floor made of simple foundation well above the ground, with office equipment provided.

o Warehouse

The warehouse will be a simple one-storey wooden structure capable of storing nursery materials.

o Garage

The garage will be a simple one-storey wooden structure having space for a truck and a wagon.

o Resthouse

The resthouse will be a one-storey wooden structure with wooden walls extending

only halfway up to the ceiling to provide ventilation, having simple facilities for workers to enjoy a rest.

o Workshop

The workshop will be a simple one-storey wooden structure to protect workers from rain and strong sunshine. The workshop will be used for the storage and preparation of material soil, the filling of pots with soil, the replanting of seedlings into pots, and the temporary storage of potted seedlings.

o Soil Burning Place

A soil burning place will be a simple one-storey wooden structure to protect workers from the rain and sunhine. Soil will be burnt on an iron plate fueled by wood.

o Storage of Burnt Soil

Burnt soil will be temporarily stored in a one-storey wooden structure with a cement floor. It will have wooden walls, and be sufficient to protect workers from the rain and sunshine.

(d) Vehicles

The following vehicles will be needed for efficient nursery works, producing of sound seedlings, and adequate nursery management.

Truck	4 tons	1
Tractor	Wheel Type with Trailor	1
Wagon		1

Duration shall be five years.

4-2-2 The Reservation of Seed Resources

Good re/afforestation results can be obtained from the optimum relationship among genetic characteristics of seeds, the re/afforestation environment and silvicultural techniques.

In terms of genetic characteristics, seeds must have genes that will produce good-quality trees. This depends on the area the seeds are obtained and the quality of the mother tree.

The importance of the origin of the seeds and the quality of the mother tree has been verified by results of past re/afforestation programs.

Even though seeds are fresh and vigorous, if their origin and mother tree are unknown, they will cause probems in the result of re/afforestation. It is essential that the sources be identified.

Seeds used in re/afforestation will be obtained by the following methods.

4-2-2-1 Current Measures

Good seeds are obtained from good mother trees which are selected by their growth in the site condition and at the age of the stand. Their trunks should be straight and the branches should be thin and fall naturally. They must not be affected by damage from blight or noxious insects.

Source of seeds, i.e. mother tree stands, should mostly consist of good mother trees, without trees which have thick branches, wide crowns and poor growth.

Regarding *Acacia mangium*, for the time being, a stand suitable for seed orchard will be selected from among the existing plantations.

Good mother trees will be designated in the seed orchard and seeds will be collected from the designated trees. The seed orchard have to be maintained to ensure proper flowering and fruiting, and trees poor in size and quality must be removed.

However, since heavy thinning is dangerous, thinning should be carried out a few times so that the stand will consist finally of 200 trees per ha with the tree crowns receiving sufficient sunlight.

Another means of obtaining seeds is to buy them from the Forest Research Centre of the Forest Department, which is very careful in selecting and supplying seeds collected from good mother trees.

4-2-2-2 The Establishment of a Seed Orchard and the Production of Improved Seeds

The establishment and expansion of plantations demands the continuous production of improved seedlings. Improved seedlings will be produced from seeds collected from a seed orchard which, in turn, should be established by tree breeding system.

The method of establishing a seed orchard will be discussed in Section 4-2-4-2.

4-2-3 Standards of Nursery Practices

4-2-3-1 The System of Nursery Practices

Seedlings of *Acacia mangium* and *Paraserianthes falcataria* will be produced in pots.

In the case of *Acacia mangium*, young seedlings grown in the sowing bed will be transplanted into pots and outplanted. For *Paraserianthes falcataria* and other species, seeds will be sowed directly in pots to produce seedlings.

Common black vinyl pots (4.5 cm in diameter; 18 cm in depth) will be used. Figure 4-3 illustrates the stages of seedling production.

Table 4-4 shows the nursery practices undertaken through one year.

Figure 4-3 Seedling Production Chart

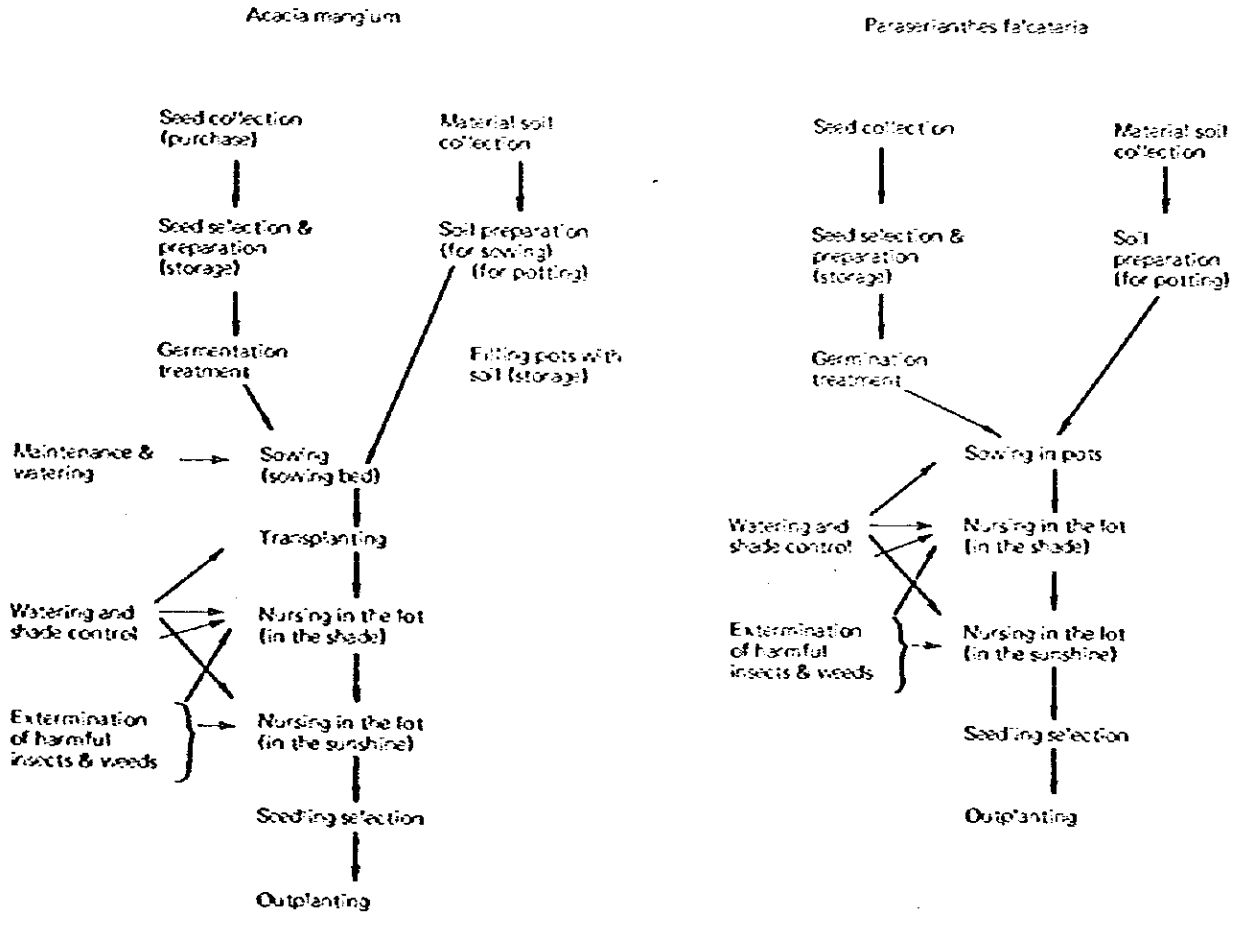
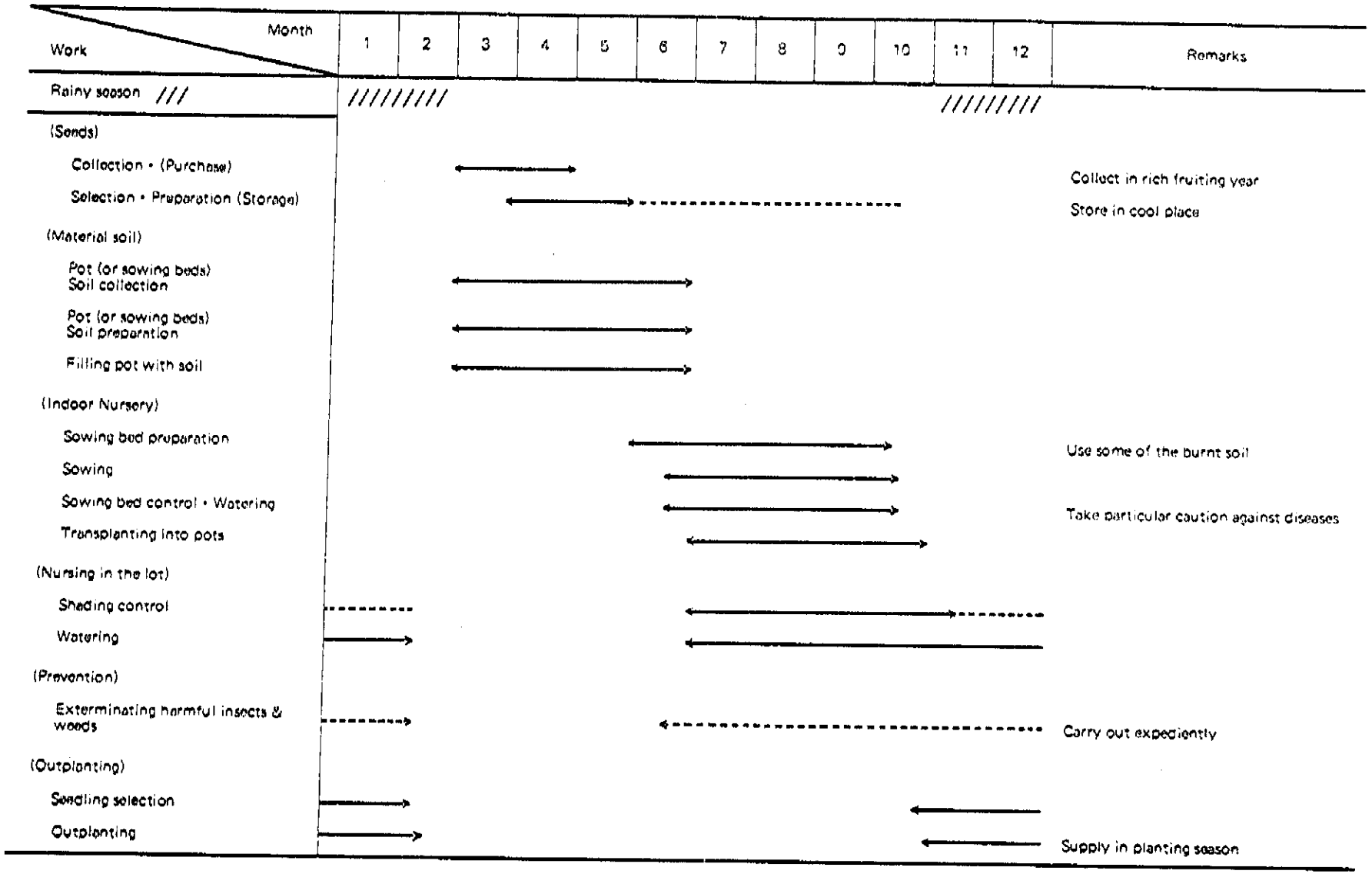


Table 4-4 Nursery Calendar



4-2-3-2 The Nursery Process

(a) Obtaining Seeds

Acacia mangium seeds will be obtained by the method referred to in Section 4-2-2. Seeds of other species are to be collected from their trees or purchased.

It is recommended that tree breeding be swiftly carried out to supply seeds from the seed orchard.

(b) The Collection and Preparation of Nursery Soil

The soil required for the potting and sowing beds is easily obtainable in the proposed re/afforestation area. It will be transported to the nursery site to be prepared for potting by crushing, sieving and mixing with fertilizers. The material soil for the sowing beds has to be burnt.

(c) Filling Pots with Soil

In the case of transplanting after preparation, the soil will be put into pots. In the case of direct sowing, the upper 3-5 cm of the filling is to consist of the burnt soil which is prepared for the sowing beds.

(d) Germination Treatment

Acacia mangium seeds will then undergo germination treatment which involves putting the seeds in hot water and then leaving in cold water during the day prior to sowing.

(e) Sowing

In the case of *Acacia mangium*, treated seeds will be sowed in the sowing beds at a rate of 2,000 ~ 2,500 pieces per m^2. They will have to be covered with polyethylene sheets for a week after sowing.

Burnt soil will be used in the upper 2-3 cm of the soil, as well as the cover soil in sowing beds.

Seeds of *Paraserianthes falcataria* and other species will be sowed directly in the pots.

The good seeds (breeding seeds) of *Acacia mangium* can be sowed directly in the pots.

(f) Transplanting into Pots

Young seedlings of *Acacia mangium* will be transplanted into well-watered pots by pallet or by hand, after digging holes with the sticks.

Pots into which young seedlings are transplanted will be placed in the frames of 5 cm meshes in the shaded beds.

(g) Maintenance in the Lot

Acacia mangium seedlings should be put in shade control for about two weeks, then raised in the sunshine for about three weeks.

Paraserianthes falcataria seedlings and other species will be maintained indoors, or in beds covered with vinyl sheets to protect them from sunlight and rain, for about two weeks; then put in the shade control for the same period before raising in the sunshine for about three months.

During this time watering should be done according to the dryness of the pot soil.

(h) The Selection and Outplanting of Seedlings

After the above-mentioned nursery process, those seedlings which have grown to a height of 30 cm or more will be outplanted.

For outplanting, seedlings which have grown soundly to a height of at least 30 cm, and which are healthy and free of damage caused by blight or noxious insects, will be selected.

4-2-4 Producing Good Seeds

4-2-4-1 The Necessity for Tree Breeding

The selection of good characteristics of tree is the first step in reafforestation and timber production.

In many cases, what is neglected is the examination of the genetic characteristics of trees for the re/afforestation project. It is obvious that selecting poor-quality material plants will cause incalculable damage to the project. Thus, the selection of trees with good genetic characteristics is essential.

Since there exists much ontogenetic mutation in *Acacia mangium*, *Paraserianthes falcataria* and *Gmelina arborea*, the subsequent effects on tree breeding can be anticipated, and its necessity is obvious.

4-2-4-2 Group Selection Breeding

Methods of tree breeding include selection breeding, cross breeding, and heterosis breeding. Of these, selection breeding will be given the urgent priority in this project. That is, plants have to be continuously selected by group selection breeding.

This method, to create man-made forests, involves selecting a number of trees with the desirable characteristics, and mixing the seeds produced by the random crossing of their clones.

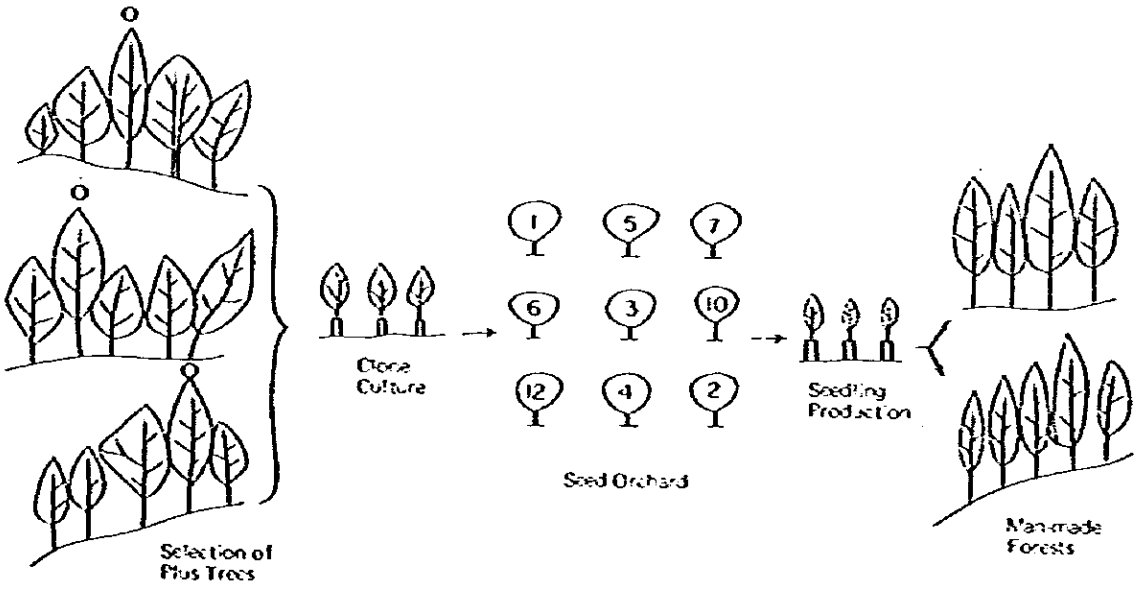
As the selection of trees with these desirable characteristics from such forests is constantly repeated, higher-quality hybrid groups are likely to be developed.

This process is illustrated in Figure 4-4.

As illustrated below, trees of good size and quality will be selected from a number of stands and their clones then cultured.

The seeds orchard must be prepared by laying out the culture clones to prevent self-pollination. Seeds produced by random crossing in the seed orchard will be used for actual plantations. The selection of plus trees and the arrangement of clones in the seed orchard has to be made under the guidance of tree breeding experts.

Figure 4-4 Selection Breeding



4-3 Forest Roads

4-3-1 The Classification of Forest Roads

Forest roads are defined as facilities constructed to provide the transport routes necessary for forest management and the transportation of forest products inside and outside forests. Accordingly, the forest roads to be constructed in Division V are similar to the multi-purpose forest roads which contribute to the needs for transport in the daily life of the local people. Although they are termed forest roads in this project, they may be regarded as public roads, and in this sense, it is proper that they were called simply "roads" in the original plan.

The original plan classified forests roads into two categories: feeder roads (5.4 m in width; 0.4 m at the shoulder; 10.2 cm surface gravel) and access road (unsurfaced). This terminology has since been changed and feeder roads are now called forest roads and access roads, forest trucks. The classifications used in the modified plan are forest roads and forest tracks.

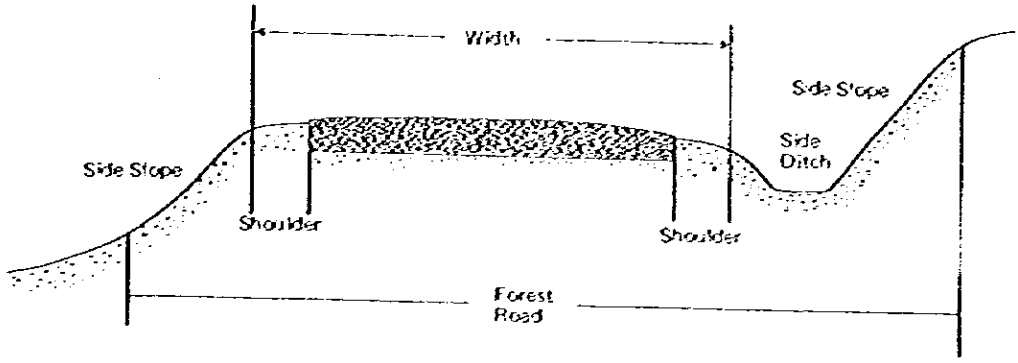
Forest roads will be designed also to act as fire breaks (together with the fire break belts discussed later), and to make fire control networks. Aiming at the effective fire control, the forest roads will be built to fit in with the natural terrain. As much as possible efficient use should be made of existing roads leading in and out of Division V, by undertaking regular road maintenance.

4-3-2 Structure

In Japan, the first-class forest roads generally have a width of 4.6 m (width of the shoulders plus actual road width), and second class forest roads, 3.6 m.

In the modified plan, forest roads, will be 6.0 m (5.0 m in actual width; 1.0 m shoulder) and forest tracks 4.6 m (4 m; 0.6m) in the expectation of large-size vehicles being used, as well as considering the use by the local people.

Figure 4-5 Forest Road Cross-Section



Note: Forest roads will be covered with gravel with a thickness of 10 cm, and feeder roads will be laid with gravel of the appropriate thickness at the time of maintenance.

4-3-3 Road Alignment

The alignment of forest roads greatly affects the speed, safety and efficiency of traffic. Although they should be ideally straight, they are inevitably curved because of the terrain. In addition, forest roads in Division V, as already mentioned, will be combined with fire break belts to surround plantations as countermeasures against fire, so the alignment of these roads is more complex than for general roads.

Division V is located in gently sloping terrain, and little care is needed in the design of curving the roads, but the gradient of the curve should be, from the point of view of traffic safety, as gentle as possible.

No limits to traverse and cross grades are set; nevertheless, they should be determined by taking into consideration the level of traffic safety required for the particular terrain.

4-3-4 Drainage Facilities

There is topographically no danger of rockslides, but there is the strong possibility of soil erosion owing to rain on the side slopes and road surface. Drainage to prevent soil erosion involves digging side and cross ditches as wide as possible, in consideration of terrain,

soil condition and precipitation. If water that gathers in the side ditches flows long distances, it could flow over the surface of the road. It is therefore important to remove water downwards by the cross ditches. The distance between the cross ditches will vary according to terrain, grade, and the structure of the side ditch. In the modified plan, however, they will be dug at an interval of approximately 150 m on main forest roads only.

4-3-5 Machinery

The machinery to be used for the maintenance of the forest roads has to be determined in terms of the structure of the roads, the topography and the efficiency of the machinery. In modified plan, the following machinery, because of their suitability for the conditions of this area, will be used in Division V.

Table 4-5 Machinery for Road Maintenance

Type	Capacity	Unit	Unit price (M$)	Remarks
Motor Grader	Hp 120 Blade 3 m	1	230,000	Used also for clearing land in the base camp and fire break belts
Front-end Loader	HP 80 1 m³	1	150,000	
Dump Truck	HP 100 6 t	2	75,000	
Bulldozer	HP 150 15 t	1	270,000	

4-4 Forest Fire Prevention Measures

4-4-1 Introduction

The damage caused by fire, to natural forests and to a man-made forest with *Acacia mangium* in Hobut, were confirmed in the field survey. These fires, caused by the unusual dry weather in several decades, were immense in their size and impact. In implementing the re/afforestation project, therefore, countermeasures have to be initially taken to prevent any fire outbreaks, with sufficient fire protection facilities being available to minimize damage should fire occur.

It is obvious that the understanding and cooperation of the local people should be obtained through constant dialogue. An even more important consideration, however, is the necessity to take effective measures to minimize fire damage, according to the topography, geography and past examples of fire in Division V.

The actual forest fire countermeasures will be explained below.

4-4-2 The Fire Break Network of Roads and Belts

It is essential to establish a system, as mentioned later, in which a fire can be detected early. If the forests are, however, enclosed by a network of forest roads and fire break belts, fires can often be prevented from spreading and causing greater damage, even if detection is late. The effectiveness of this system has been already verified in the Cooperative Afforestation Project in Pantabangan Area between the Republic of the Philippines and Japan.

This network of forest roads and fire break belts is illustrated in Figure 4-6. Clearing a certain width on both sides of the forest roads by weeding would enhance fire prevention. The appropriate tree species which are resistant to fire should be selected when side slopes are forested against soil erosion.

4-4-3 Watch Towers and the Communications Network

As already mentioned, minimizing fire damage requires an early detection system. For this purpose, it is important to build watch towers from which forests should be watched during periods of high fire risk, and to maintain constant radio communication between the administration office and the watch towers.

In Division V, the construction of watch towers is to be launched at the same time as the re/afforestation itself and they will be increased in number as the re/afforestation area is extended. As long as the towers serve their purpose they do not have to be built to last forever. The number of towers is not specified, but they have to be built to make watching effective (see Figure 4-7).

Figure 4-6 Fire Break Network of Forest Roads and Fire Break Belts

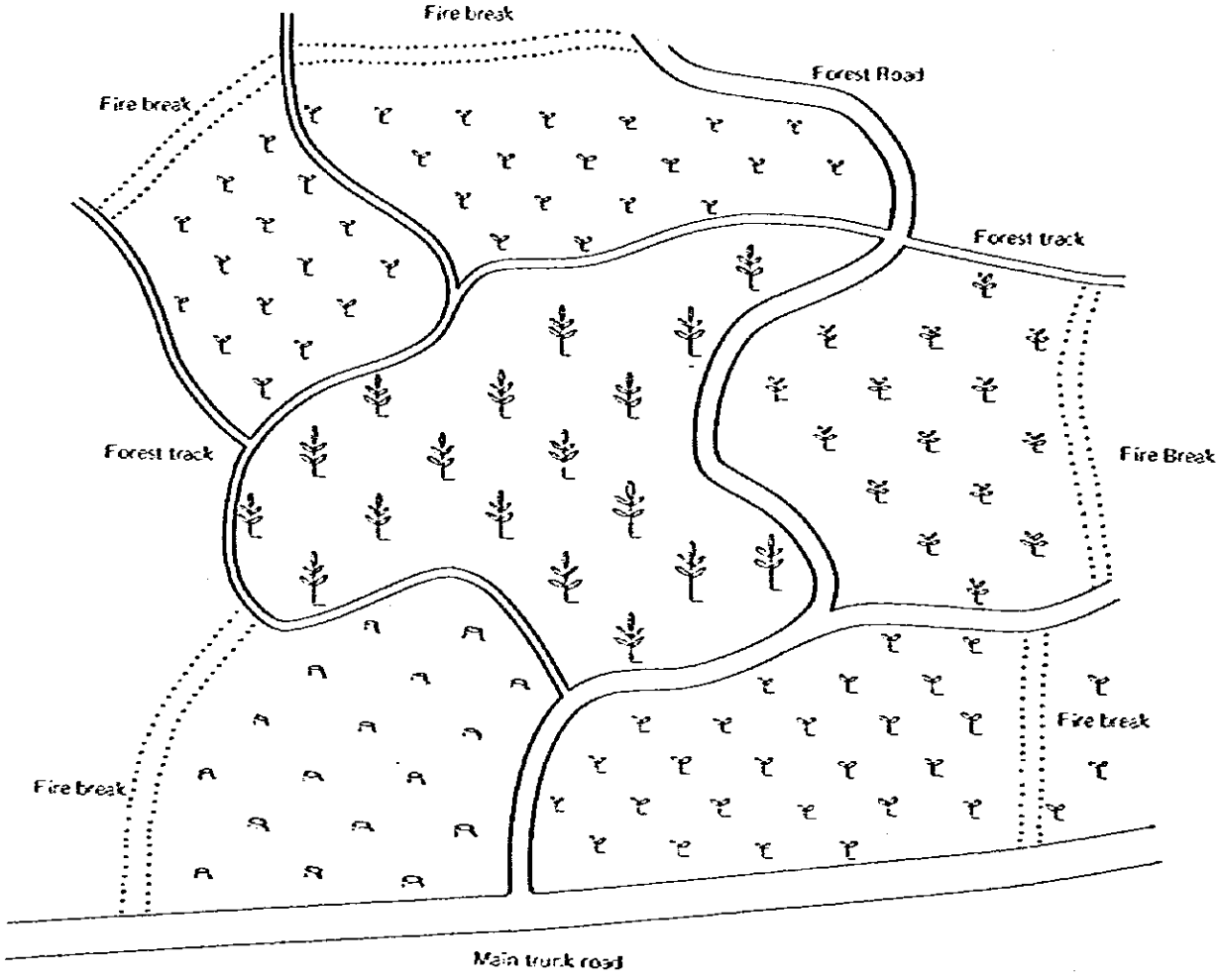
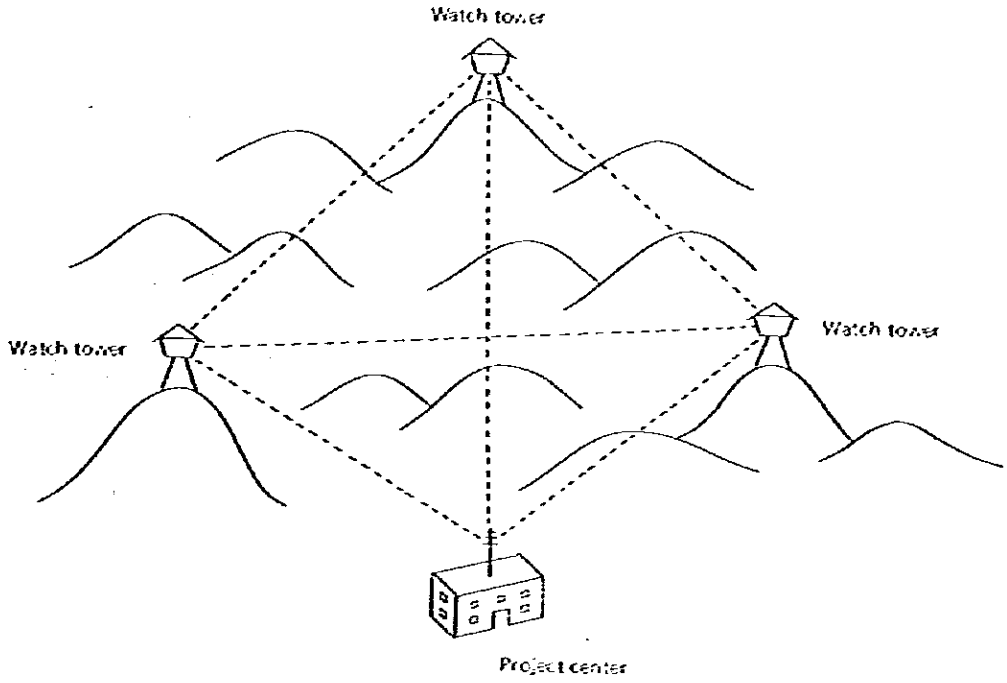


Figure 4-7 Watch Towers and the Communications Network



4-4-4 Fire-fighting Equipment and the Fire-fighting Unit

Fire-fighting equipment will be provided as re/afforestation expand but for the time being inexpensive and effective fire slappers and rakes will be used.

The fire-fighting unit should be well-organized and it is extremely important to train them thoroughly in the use of the fire-fighting equipment. The unit should be organized by consulting with the settlers.

4-4-5 Consultation with Settlers

Successful re/afforestation will be further achieved through ongoing discussion with the local people to obtain their understanding and cooperation in the project.

For its success in working alongside the local inhabitants, the Kingdom of Nepal

gained much attention with its Community Forestry Development Project launched in 1979, with the technical support of FAO and the financial aid of the World Bank.

The Nepal project involved the local people in the management of the national forests, at the same time as improving their living standards. Previously, only a few local people had been involved. There are many useful lessons to be learnt from the project. In particular, the present project should aim at stabilizing the lives of the local people by taking into account their opinions regarding the project.

4-5 Countermeasures against Disease and Insect Damage

4-5-1 Introduction

Disease and insect damage in the nursery and plantations is a serious problem. Particularly for the exotic tree species to be introduced into the area there are many unknown factors which necessitate careful consideration.

To prevent the outbreak of disease or insect damage, the following steps should be taken:

- o Select species of resistive provenance and clone;
- o Avoid, as far as possible, establishing a monoculture on a large scale;
- o Confirm resistivity against disease and insect damage through at least one rotation.

Nevertheless, disease and insect damage often occurs due to unusual weather or changes in the environment. Therefore, in order, to keep damage in these cases to a minimum, the following measures should be adopted.

- o Seek to detect and contain at early stage of damage.
- o Discover the affected areas and the causes by constant patrolling.
- o When the cause of the damage is determined, attempt to remove it to the full extent.
- o Carry out thorough extermination to minimize the damage.
- o Do not bring the diseased seedlings and those infested with harmful insects into the plantation.

4-5-2 Countermeasures against Disease

(1) Disease Damage in the Nursery

In nursery operations in hot humid climates the utmost caution should be taken against the outbreak of disease. Pathogen sometimes adheres to soil in the nursery bed or to seeds. In the case of infected soil, sterilization of the soil using chemicals, or soil burning (especially for sowing) should be carried out. The seeds should be sterilized before sowing.

Diseased seedlings are either removed and burned, and the healthy seedlings should be correctly treated as soon as possible.

It should be emphasized that the diseased seedlings must not be outplanted and if there is any danger of healthy seedlings being infected, they must be treated prior to outplanting.

(2) Disease Damage in Plantations

In the case of diseases in plantations, when it occurs in individual trees, it often goes unnoticed, resulting in increased damage and destruction of the plantations over large areas. Principally, damage should be prevented by patrolling to ensure early detection and containment. Diseased fallen branches and litter are collected and burned. If widespread damage is feared, the surrounding areas should be sprayed using chemicals.

If the damage is likely to spread to large areas, it is most important to spray thoroughly and as early as possible to prevent damage from spreading further.

4-5-3 Countermeasures against Insect Damage

(1) Insect Damage in the Nursery

Insects can attack the stems, leaves and buds of seedlings, retarding their growth or making outplanting impossible by deforming the tree shape. Outbreaks of harmful insect infestation are closely related to the prevailing weather conditions and the area surrounding the nursery. Consequently, these areas should be cleared thoroughly to remove the conditions suitable for harmful insect habitation; also, the nursery shuld be separated from the adjoining area by protective tree belts and paths.

If insect damage occurs, insecticide spraying should immediately be carried out, and the harmful insect breeding area infecting the nursery should be sprayed.

(2) Insect Damage in Plantations

If the food for insects is abundant, there is strong likelihood of insects mass breeding. As a result, when conditions are most suitable for insect breeding, damage is likely to spread within a very short time.

Therefore, as mentioned previously, prevention can be achieved by patrolling for early detection and containment, and if there is a possibility of the damage spreading, insecticide should be sprayed over the surrounding areas.

5. Implementation Plan

5-1 Re/afforestation Plan

The yearly re/afforestation plan is made based on the re/afforestation operations described in Section 4, "Forest Working Plan".

To conduct the re/afforestation work in Division V, 9,000 hectares will be divided into three parcels (I, II and III), as described in "4-1-1 Planting Area". In each parcel 200 hectares will be planted every year; so the three parcels combined will involve 600 hectares of planting being carried out annually, resulting in 9,000 hectares being planted in 15 years.

The re/afforestation work in each parcel to be carried out under the direction of an assistant plantation officer assigned to each parcel will be described in "5-6 Administration Plan".

5-1-1 Extent of Re/afforestation Work

A series of operations, including land preparation, planting, tending and protection, will be carried out in accordance with the annual program.

Regarding the re/afforestation works, it is essential to perform each operation in the suitable season in which it can be carried out most efficiently, at the same time not forgetting that the growing of the planted trees is the primary object; and to do this the project should be carried out systematically, ensuring the availability of the necessary labor and carefully planning the operational responsibilities. The operation chart for the annual re/afforestation work is shown in Table 5-1.

5-1-2 Standards of Re/afforestation Works

To insure the success of the re/afforestation plan, the work standards have been for-

mulated by fully assessing the social environment, topography, geology, soil, vegetation, and labor conditions in Division V, by referring to the Standards of Re/afforestation Plan (made by Japan International Cooperation Agency).

To be successfully implemented, the afforestation works need to be determined by thoroughly understanding the particular conditions of the working site on the basis of the above-mentioned working standards. The factors are listed in Table 5-2.

5-1-3 Number of Workers and Cost of Re/afforestation Operations

The number of workers and the cost of the re/afforestation work were calculated on the basis of the annual re/aforestation operations and the re/afforestation work.

Annual labor and other costs are shown in Table 5-3, and Table 5-4, respectively.

5-1-4 Facilities Necessary for Re/afforestation Operations

Facilities and the costs to be incurred in the carrying out of the re/afforestation plan are shown in Table 5-5.

5-1-5 Cost of Re/afforestation Operations

Annual direct cost of labor, facilities and vehicles are shown in Table 5-6.

5-2 Nursery Program

The annual nursery program has been established within the annual re/afforestation program in order that healthy seedlings will be produced and outplanted in time for the planting season. Nursery practice will be carried out in accordance with the above-mentioned standards for nursery practice.

Table 5-1 Annual Re/afforestation Operations

(Unit: ha)

Operation \ Year	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th	16th	17th	18th
Land preparation		600	600	600	600	600	600	600	600	600	600	600	600	600	600	600		
Bush cutting		(300)														(300)		
Weeding		(600)	The same as left in each year.													(600)		
Burning		(600)														(600)		
Planting		300	600	600	600	600	600	600	600	600	600	600	600	600	600	600	300	
Staking		(300)	(600)													(600)	(300)	
Holing		(300)	(600)													(600)	(300)	
Seedling transporting		(300)	(600)	The same as left in each year.												(600)	(300)	
Fertilizing		(300)	(600)													(600)	(300)	
Planting		(300)	(600)													(600)	(300)	
Weeding			600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	
Supplementary planting			600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	
Vine cutting			300	600	600	600	600	600	600	600	600	600	600	600	600	600	600	300
Improvement cutting I				600	600	600	600	600	600	600	600	600	600	600	600	600	600	600
Improvement cutting II					600	600	600	600	600	600	600	600	600	600	600	600	600	600
Pruning I					600	600	600	600	600	600	600	600	600	600	600	600	600	600
Pruning II								600	600	600	600	600	600	600	600	600	600	600
Thinning I									600	600	600	600	600	600	600	600	600	600
Thinning II													600	600	600	600	600	600

Table 5-2 Standard of Re/afforestation Operations (per hectare)

(Unit: per ha)

Operation	Contents	No. of workers	Unit cost (M$)	Cost (M$)	Remarks
Land preparation	Total	30.0	18	540.00	
	Felling trees of large and medium diameter	10.0	18	180.00	Chainsaw felling, 50% of prepared area
	Weeding	10.0	18	180.00	Bushknife weeding, entire prepared area
	Burning and making fire breaks	10.0	18	180.00	Entire prepared area
Planting	Total	10.8		188.40	Spacing: 1,110 seedlings/ha
	Staking	3.0	16	48.00	370 poles per day per person
	Holing	3.0	18	54.00	370 holing per day per person
	Seedling transporting from forest road to planting area	0.2	18	3.60	5,550 seedlings per day per person
	Fertilizing	0.8	18	14.40	1,388 seedlings fertilization per day per person
	Planting	3.8	18	68.40	292 seedlings per day per person
Weeding	3 weedings a year	12.0	18	216.00	The 2nd, 5th, and 8th months after planting
Supplementary planting	10% of planted trees	1.2	18	21.60	92 seedlings per day per person, seedling transportation included
Vine cutting	2 vine cuttings a year	4.0	16	64.00	First in the 12 months after planting, second in the 18th
Improvement cutting I	Remove all branches to leave trunk only to make one stem	0.5	18	9.00	18th month after planting
Improvement cutting II	Remove 40% of standing trees, including culled trees	6.0	18	108.00	3rd year after planting, 444 trees/ha, 74 trees per day per person
Pruning I	Cut live and dead branches 1/3 tree height	8.0	18	144.00	After improvement cutting, 3rd year after planting, 666 trees/ha, 83 trees per day per person
Pruning II	Cut live and dead branches up to the suitable height	10.0	18	180.00	6th year after planting, 400/ha, 40 per day per person
Thinning I	Thin 20% of standing trees/ha	5.0	18	90.00	7th year after planting, 133/ha, 27 per day per person
Thinning II	Thin 25% of standing trees/ha	8.0	18	144.00	11th year after planting, 133/ha, 17 per day per person

Table 5-3 Number of Man-days for Re/afforestation Operations (annual basis)

(Unit: Man-days)

Operation \ Year	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th	16th	17th
Land preparation		15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	
Felling		(3,000)														(3,000)	
Weeding		(6,000)		The same as left in each year.												(6,000)	
Burning		(6,000)														(6,000)	
Planting		3,240	6,480	6,480	6,480	6,480	6,480	6,480	6,480	6,480	6,480	6,480	6,480	6,480	6,480	6,480	3,240
Staking		(900)	(1,800)													(1,800)	(900)
Holing		(900)	(1,800)													(1,800)	(900)
Seedling transporting		(60)	(120)		The same as left in each year.											(120)	(60)
Fertilizing		(240)	(480)													(480)	(240)
Planting		(1,140)	(2,280)													(2,280)	(1,140)
Weeding			7,200	7,200	7,200	7,200	7,200	7,200	7,200	7,200	7,200	7,200	7,200	7,200	7,200	7,200	7,200
Supplementary planting			720	720	720	720	720	720	720	720	720	720	720	720	720	720	720
Vine cutting			1,200	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400
Improvement cutting I				300	300	300	300	300	300	300	300	300	300	300	300	300	300
Improvement cutting II					3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600
Pruning I					4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800
Pruning II								6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000
Thinning I									3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000
Thinning II													4,800	4,800	4,800	4,800	4,800
Total		18,240	30,600	32,100	40,500	40,500	40,500	46,500	49,500	49,500	49,500	49,500	54,300	54,300	54,300	54,300	36,060

Table 5-4 Annual Labor Costs of Re/afforestation Operations

(Unit: MS)

Operation \ Year	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th	16th	17th
Land preparation		270,000	270,000	270,000	270,000	270,000	270,000	270,000	270,000	270,000	270,000	270,000	270,000	270,000	270,000	270,000	
Brush cutting		(54,000)														(54,000)	
Weeding		(108,000)		The same as left in each year.												(108,000)	
Burning		(108,000)														(108,000)	
Planting		56,520	113,040	113,040	113,040	113,040	113,040	113,040	113,040	113,040	113,040	113,040	113,040	113,040	113,040	113,040	56,520
Sticking		(14,400)	(28,800)													(28,800)	(14,400)
Digging		(16,200)	(32,400)													(32,400)	(16,200)
Seedling transporting		(1,080)	(2,160)		The same as left in each year.											(2,160)	(1,080)
Fertilizing		(4,320)	(8,640)													(8,640)	(4,320)
Planting		(20,520)	(41,040)													(41,040)	(20,520)
Weeding			129,600	129,600	129,600	129,600	129,600	129,600	129,600	129,600	129,600	129,600	129,600	129,600	129,600	129,600	129,600
Supplementary planting			12,960	12,960	12,960	12,960	12,960	12,960	12,960	12,960	12,960	12,960	12,960	12,960	12,960	12,960	12,960
Vine cutting			19,200	38,400	38,400	38,400	38,400	38,400	38,400	38,400	38,400	38,400	38,400	38,400	38,400	38,400	38,400
Improvement cutting I				5,400	5,400	5,400	5,400	5,400	5,400	5,400	5,400	5,400	5,400	5,400	5,400	5,400	5,400
Improvement cutting II					64,800	64,800	64,800	64,800	64,800	64,800	64,800	64,800	64,800	64,800	64,800	64,800	64,800
Pruning I					86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400
Pruning II								108,000	108,000	108,000	108,000	108,000	108,000	108,000	108,000	108,000	108,000
Thinning I									54,000	54,000	54,000	54,000	54,000	54,000	54,000	54,000	54,000
Thinning II													86,400	86,400	86,400	86,400	86,400
Total		326,520	544,800	569,400	720,600	720,600	720,600	828,600	882,600	882,600	882,600	882,600	969,000	969,000	969,000	969,000	642,480

Table 5-5 Facilities and Costs in Re/afforestation Operations

		Buildings						Vehicles						Grand total
		Plantation office	Ware house	Garage	Work-shop	Maintenance	Total	Trucks	Tractors	Wagons	Maintenance	Equipment	Total	
Size, type		40 m²	60 m²	100 m²	50 m²			4WD, 4 ton	Wheel type	4WD		Chainsaw, bush-cutter, and others		
Number		1	1	1	3			3	3	4				
Unit price (M$)		500	300	200	300			50,000	25,000	35,000	109,500	20,000		
Total cost (M$)		20,000	18,000	20,000	45,000	10,300		150,000	75,000	140,000				
Year	1st	20,000	18,000	20,000	45,000		103,000							103,000
	2nd					10,300	10,300	150,000	75,000	140,000	109,500	20,000	494,500	504,800
	3rd					10,300	10,300				109,500	20,000	129,500	139,800
	4th					10,300	10,300				109,500	20,000	129,500	139,800
	5th					10,300	10,300				109,500	20,000	129,500	139,800
	6th					10,300	10,300				109,500	20,000	129,500	139,800
	7th					10,300	10,300	150,000	75,000	140,000	109,500	20,000	494,500	504,800
	8th					10,300	10,300				109,500	20,000	129,500	139,800
	9th					10,300	10,300				109,500	20,000	129,500	139,800
	10th					10,300	10,300				109,500	20,000	129,500	139,800
	11th					10,300	10,300				109,500	20,000	129,500	139,800
	12th					10,300	10,300	150,000	75,000	140,000	109,500	20,000	494,500	504,800
	13th					10,300	10,300				109,500	20,000	129,500	139,800
	14th					10,300	10,300				109,500	20,000	129,500	139,800
	15th					10,300	10,300				109,500	20,000	129,500	139,800
	16th					10,300	10,300				109,500	20,000	129,500	139,800
	17th					10,300	10,300	(150,000)*	(75,000)*	(140,000)*	109,500	20,000	129,500	139,800
Total		20,000	18,000	20,000	45,000	164,800	267,800	450,000	225,000	420,000	1,752,000	320,000	3,167,000	3,434,800

* Figure in parentheses are the case of continued operation; not included in the total.

Table 5-6 Annual Costs of Re/afforestation Operations

Year	Planting area (ha)	Number of workers	Labor (M$)	Drivers (M$)	Buildings (M$)	Vehicles (M$)	Maintenance (including repair) (M$)	Materials (reafforest. equipment) (M$)	Fertilizer (40M$/ha) (M$)	Total (M$)
1st					103,000					103,000
2nd	300	18,240	326,520	8,640	10,300	365,000	109,500	20,000	12,000	851,960
3rd	600	30,600	544,800	8,640	10,300		109,500	20,000	24,000	717,240
4th	600	32,100	569,400	17,280	10,300		109,500	20,000	24,000	750,480
5th	600	40,500	720,600	17,280	10,300		109,500	20,000	24,000	901,680
6th	600	40,500	720,600	25,920	10,300		109,500	20,000	24,000	910,320
7th	600	40,500	720,600	25,920	10,300	365,000	109,500	20,000	24,000	1,275,320
8th	600	46,500	828,600	25,920	10,300		109,500	20,000	24,000	1,018,320
9th	600	49,500	882,600	25,920	10,300		109,500	20,000	24,000	1,072,320
10th	600	49,500	882,600	25,920	10,300		109,500	20,000	24,000	1,072,320
11th	600	49,500	882,600	25,920	10,300		109,500	20,000	24,000	1,072,320
12th	600	49,500	882,600	25,920	10,300	365,000	109,500	20,000	24,000	1,437,320
13th	600	54,300	969,000	25,920	10,300		109,500	20,000	24,000	1,158,720
14th	600	54,300	969,000	25,920	10,300		109,500	20,000	24,000	1,158,720
15th	600	54,300	969,000	25,920	10,300		109,500	20,000	24,000	1,158,720
16th	600	54,300	969,000	25,920	10,300		109,500	20,000	24,000	1,158,720
17th	600*	54,300*	969,000*	25,920	10,300	365,000	109,500	20,000	24,000*	1,523,720
Total	9,300	718,440	12,306,520	362,880	267,800	1,460,000	1,752,000	320,000	372,000	17,341,200

Note: Final cutting age is 15 years. After the 17th year, cutting and reafforestation are done. (Cost of reafforestation is not included here.)
* indicates 2nd cycle of plantation.

5-2-1 Nursery Construction Plan

Silvicultural operations will begin with the construction of the nursery, to be followed by seed collection and seedling production, planting and tending etc. Nursery construction has been scheduled so that planting can commence in the second year of operation. The nursery construction schedule is shown in Table 5-7.

An analysis of the costs involved in nursery construction is shown in Table 5-8.

5-2-2 Seedling Production Plan

Operations, from seed collection to seedling production and outplanting, have been planned in compliance with the standards of nursery practices. Table 5-9 shows the planned level of seed collection and seedling production.

5-2-3 Based on the Standard Efficiency for Nursery Practice

To implement the above nursery plan, the standard efficiency for nursery practice has been formulated under the consideration of the labor conditions and the social environment in Division V based on the standard for nursery practice (Section 4-2-3).

The Standard Efficiency for Nursery Practice is shown in Table 5-10.

5-2-4 Costs and Laborers for Nursery Work

The labor costs and the manpower required in the nursery operations have been estimated in accordance with the nursery program, as shown in Tables 5-11 and 5-12.

Table 5-13 shows the necessary expenditure including direct costs of facilities and vehicles required for seedling production.

Table 5-7 Nursery Construction Schedule

Items \ Month	1	2	3	4	5	6	7	8	9	10	11	12
Bush clearing			←	→								
Road construction	←	→										
Ground survey (by land use)					←	→						
Lot preparation						←		→				
Nursery facilities construction							←			→		
Watering facilities construction							←			→		
Workshop construction								←			→	
Office construction								←				→
Warehouse and garage construction									←			→
Rest house construction									←			→
Seedling production							← 2nd year					
Outplanting											← 2nd year	

Table 5-8 Costs of Nursery Construction

Costs	Item	Quantity	Unit price (M$)	Sum (M$)	Remarks
Lot preparation cost	Bush clearing Lot preparation	8,000 m²	560/ha	448	Lot for nursery and attached facilities
	Road construction	430 m width: 4 m, 1,720 m²	1.30/m	559	
	Others			5,025	Hire of bulldozer, Miscellaneous work
			Total	6,032	
Nursery facilities cost	Construction of the following facilities:				
	Sowing beds	185 m²	4.03	746	Duration: 5 years Wooden frame: 10 cm Sowing beds: 4 rotations/year
	Potted seeding beds	1,450 m²	4.10	5,945	Duration: 5 years
	Shading facilities	1,450 m²	1.00	1,450	Duration: 5 years
	Watering facilities	1,035 m²	6.30	10,301	Duration: 20 years
			Total	18,442	Annual maintenance cost at 10%: M$1,850
Building cost	Nursery office	80 m²	500.00	40,000	One-storey wooden building Duration: 20 years
	Warehouse	100 m²	300.00	30,000	Duration: 20 years
	Garage	100 m²	200.00	20,000	Duration: 20 years
	Rest house	200 m²	300.00	60,000	Duration: 20 years
	Workshop	300 m²	200.00	60,000	Duration: 20 years
	Soil burning place	25 m²	200.00	5,000	Duration: 20 years
	Burnt soil storage	25 m²	200.00	5,000	Duration: 20 years
			Total	220,000	Annual maintenance cost at 10%: M$22,000
Vehicle cost	Truck (4 ton)	1	50,000.00	50,000	Duration: 5 years
	Tractor (wheel type)	1	25,000.00	25,000	Renewal every six years
	Wagon (4WD)	1	35,000.00	35,000	Renewal every six years
			Total	110,000	Annual maintenance cost at 15%: M$16,500
Grand total				354,472	

Table 5-9 Annual Production of Seeds and Seedlings

Year	Planting area (ha)	Species	Required seeds (kg)	Required seedlings	(Outplanted seedlings)	Remarks
2	240	Acacia mangium	10.2	366,300	(293,040)	35,840 seedlings per kg
	60	Paraserianthes falcataria, others	3.55	91,575	(73,260)	25,600 seedlings per kg
Sub-total	300		13.75	457,875	(366,300)	
3	480	Acacia mangium	20.4	732,600	(586,080)	The same as above.
	120	Paraserianthes falcataria, others	7.1	183,150	(146,520)	
Sub-total	600		27.5	915,750	(732,600)	
⟨		The same as above in each year.				
16	480	Acacia mangium	20.4	732,600	(586,080)	The same as above.
	120	Paraserianthes falcataria, others	7.1	183,150	(146,520)	
Sub-total	600		27.5	915,750	(732,600)	
17	240	Acacia mangium	10.2	366,300	(293,040)	The same as above.
	60	Paraserianthes falcataria, others	3.55	91,575	(73,260)	
Sub-total	300		13.75	457,875	(366,300)	
Grand total	7,200		306.0	10,989,000	(8,791,200)	
	1,800		106.5	2,747,250	(2,197,800)	
	9,000		412.5	13,736,250	(10,989,000)	

Table 5-10 Standard Efficiency for Nursery Practice

(per 1 kg of seeds; per 1,000 seedlings)

Type of work	Details	Acacia mangium			Paraserianthes falcataria			Remarks
		Laborer	Unit price (M$)	Sum (M$)	Laborer	Unit price (M$)	Sum (M$)	
Seed collection	Tree selection, seed collection	1.00	18.00	18.00	1.00	18.00	18.00	Tree selection: 0.5 men.day Seed collection: 0.5 men.day (5 kg/1 days) including transportation
Seed selection and preparation	Drying, threshing, selection, and germination test	2.50	16.80	42.00	2.50	16.80	42.00	Drying, Threshing: 1 men.day/M$ 18 Selection: 0.5 men.day/M$ 16 Germination test: 1 men.day/M$ 16
Total		3.50		60.00	3.50		60.00	
Soil collection for potting	Collection and transportation of rich and sandy soils	1.50	18.00	27.00	1.50	18.00	27.00	Collection: 1 men.day Transportation: 0.5 men.day
Soil preparation for potting	Soil crushing, filtering and mixing with fertilizers	2.00	18.00	36.00	2.00	18.00	36.00	Crushing, Filtering: 1 men.day Fertilizer mixing: 1 men.day
Soil filling up	Filling up pots with soil	1.67	16.00	26.72	1.67	16.00	26.72	1 men.day: 600 bags
Preparation of sowing beds	Preparation of soil and beds	1.80	18.00	32.40	–			Preparation of soil and beds: 1.8 men.day
Sowing	Sowing seeds in beds and pots	2.00	16.00	32.00	2.00	16.00	32.00	1 men.day: 500 seeds
Maintenance and watering of sowing beds	Watering, watching	0.30	16.00	4.80	–			Appropriate watering according to dryness
Replanting in pots	Replanting, transferring and arrangement	2.67	16.00	42.72	1.00	16.00	16.00	Replanting: 1 men.day, 600 pots Arrangement: 1 men.day; 1,000 pots
Shade control	Covering and removing	0.03	16.00	0.48	0.03	16.00		150 m^2 twice by 1 men.day
Watering	Watering twice a day for 100 days	0.84	16.00	13.44	0.84	16.00	13.44	Watering 2 min/2.5 m^2
Disease and insect prevention and weeding	Prevention (twice); weeding (once)	0.03	16.00	0.48	0.03	16.00	0.48	1 men.day: 250 m^2 1,000 weeds/2.5 m^2
Selection and outplanting	Selection and arranging of seedlings	1.00	18.00	18.00	1.00	18.00	18.00	Selection: 2,000 seedlings/men.day Packing: 2,000 seedlings/men.day
Total		13.84		234.04	10.07		169.64	
Other material cost	Fertilizers, chemicals, pots, cheesecloth, etc.			15.00			15.00	Fertilizer and chemicals: M$ 8 Other material: M$ 7

Table 5-11 Laborers Required for Nursery Work

Year	Seed collection	Seedling production	Outplanting	Miscellaneous work	Total	Remarks
1				80	80	Seed collection includes selection and preparation of seeds.
2	48	5,534	366	80	6,028	
3	96	11,068	733	80	11,977	Seedling production includes soil collection, soil preparation, soil filling, preparation of sowing beds, sowing, watering, replanting, shade control, prevention and weeding.
		The same as above in each year				
16	96	11,068	733	80	11,977	Outplanting includes seedling selection.
17	48	5,534	366	80	6,028	
Total	1,440	166,020	10,994	1,360	179,814	

Table 5-12 Labor Costs for Nursery Work

(MS)

Year	Seed collection	Seedling production	Outplanting	Miscellaneous work	Total	Remarks
1				1,280	1,280	Seed collection: MS 16 - 18/men.day
2	823	93,068	6,588	1,280	101,759	Seedling production: MS 16 - 18/men.day
3	1,646	186,136	13,194	1,280	202,256	Outplanting: MS 18/men.day
		The same as above in each year				Miscellaneous work: MS 16/men.day
16	1,646	186,136	13,194	1,280	202,256	
17	823	93,068	6,588	1,280	101,759	
Total	24,690	2,792,040	197,892	21,760	3,036,382	

Table 5-13 Seedling Production Costs

(MS)

Year	Planting area (ha)	Seedling production	Number of laborers	Labor cost	Construction cost of nursery	Building cost	Vehicle cost	Maintenance cost	Material cost	Total
1			80	1,280	24,474	220,000				245,754
2	300	457,875	6,028	101,759			110,000	39,600	6,868	258,227
3	600	915,750	11,977	202,256				39,600	13,736	255,592
4	600	915,750	11,977	202,256				39,600	13,736	255,592
5	600	915,750	11,977	202,256				39,600	13,736	255,592
6	600	915,750	11,977	202,256	8,141			39,600	13,736	263,733
7	600	915,750	11,977	202,256			110,000	39,600	13,736	365,592
8	600	915,750	11,977	202,256				39,600	13,736	255,592
9	600	915,750	11,977	202,256				39,600	13,736	255,592
10	600	915,750	11,977	202,256				39,600	13,736	255,592
11	600	915,750	11,977	202,256	8,141			39,600	13,736	263,833
12	600	915,750	11,977	202,256			110,000	39,600	13,736	365,592
13	600	915,750	11,977	202,256				39,600	13,736	255,592
14	600	915,750	11,977	202,256				39,600	13,736	255,592
15	600	915,750	11,977	202,256				39,600	13,736	255,592
16	600	915,750	11,977	202,256	8,141			39,600	13,736	263,733
17	600*	915,750*	11,977	202,256			110,000	39,600	13,736*	365,592
Total	9,300	14,194,125	185,763	3,136,873	48,897	220,000	440,000	633,600	212,908	4,692,284

* Indicates 2nd cycle.

5-3 Forest Road Plan

5-3-1 Construction of the Forest Road

The forest road operation will be carried out in accordance with "4-3 Forest Road". Construction of a road to transport the materials for construction of the base is to begin in the first year from the existing Pitas-Dandon Road to the base.

A forest road of 3.6 kilometers and forest tracks of 11.8 kilometers will be built in the first year; from the second year 3.0 kilometers of forest road and 8.8 kilometers of forest tracks will be built each year. Construction of the forest road network will be completed in 15 years, with the forest roads and tracks totaling 45.6 kilometers and 135 kilometers, respectively. The ratio of the forest road network at the completion will be 5 meters per hectare for the forest roads and 15 meters per hectare for the forest tracks. The construction mentioned above will be carried out on a contract system. The proposed route of the forest roads is described in the topographic map in the compilation of materials. The forest road operations and costs of building and maintaining the forest road in each year are listed in Table 5-14, and Table 5-15, respectively.

5-3-2 Maintenance of the Forest Road

Maintenance of the forest roads will be carried out by direct operation system. The existing roads (the Pitas-Dandon Road and the Pitas-Kanibongan Road) will undergo repairs in the first year; from the second year maintenance of the constructed forest road network will be done. Machines, labor and costs involved in the maintenance of the forest roads are shown in Table 5-14, and Table 5-15 respectively.

Table 5-14 Forest Road Operations (on an annual basis)

Year	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th	16th	Total	Remarks
Construction (km)																		
Forest roads	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3		46	5 m/ha*
Forest tracks	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9		135	15 m/ha
Total	13	12	12	12	12	12	12	12	12	12	12	12	12	12	12		181	
Total length	13	25	37	49	61	73	85	97	109	121	133	145	157	169	181			
Maintenance																		
Purchase of machinis (unit)																		Depreciation
Grader	1*					1					1					1	4	5 years
Front loader	1*				1				1				1				4	4 years
Dump truck	1*		1*		1		1		1		1		1		1		8	4 years
Bulldozer	1*					1					1					1	4	5 years
Total	4		1		2	2	1		2		3		2		1	2	20	* New purchase
Labor																		
Supervisors	2	2	2	2	2	3	3	3	3	3	4	4	4	4	4	4	49	
Workers	10	10	10	10	10	15	15	15	15	15	20	20	20	20	20	20	245	
Operators	4	4	5	5	5	5	5	5	5	5	5	5	5	5	5	5	78	
Total	16	16	17	17	17	23	23	23	23	23	29	29	29	29	29	29	372	

* Include access road to the Pitas-Dandon road (about 1 km).

Table 5-15 Costs of Constructing and Maintaining the Forest Road

(per M$1,000)

Year		1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th	16th	Total
Construction	Unit cost																	
Forest road	70	280	210	210	210	210	210	210	210	210	210	210	210	210	210	210		3,220
Forest trucks	10	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90		1,350
Total		370	300	300	300	300	300	300	300	300	300	300	300	300	300	300		4,570
Maintenance & Operation																		
Purchase of machines																		
Grader	230	230					230					230					230	920
Front loader	150	150				150				150				150				600
Dump truck	75	75		75		75		75		75		75		75		75		600
Bulldozer	270	270					270					270					270	1,080
Total		725		75		225	500	75		225		575		225		75	500	3,200
Other purchase	25	25		25		25		25		25		25		25		25		200
Operation cost																		
Grader	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	768
Front loader	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	864
Dump truck	34	34	34	68	68	68	68	68	68	68	68	68	68	68	68	68	68	1,020
Bulldozer	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	1,440
Total		226	226	260	260	260	260	260	260	260	260	260	260	260	260	260	260	4,092
Labor																		
Supervisors	4.32	8.64	8.64	8.64	8.64	8.64	12.96	12.96	12.96	12.96	12.96	17.28	17.28	17.28	17.28	17.28	17.28	211.68
Workers	3.84	38.4	38.4	38.4	38.4	38.4	57.6	57.6	57.6	57.6	57.6	76.8	76.8	76.8	76.8	76.8	76.8	940.8
Operators	4.32	17.28	17.28	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6	336.96
Total		64.32	64.32	68.64	68.64	68.64	92.16	92.16	92.16	92.16	92.16	115.68	115.68	115.68	115.68	115.68	115.68	1489.44
Maintenance total		1040.32	290.32	428.64	328.64	578.64	852.16	452.16	352.16	602.16	352.16	975.68	375.68	625.68	375.68	475.68	875.68	8981.44
Total		1410.32	590.32	728.64	628.64	878.64	1152.16	752.16	652.16	902.16	652.16	1275.68	675.68	925.68	675.68	775.68	875.68	13551.44

5-4 Disease and Insect Control

In this section details will be given of the fundamental countermeasures against disease and insect damage that were outlined in Section 4-5 above.

5-4-1 Disease Control

(1) Disease Damage in the Nursery

o Damping-off

This disease tends to occur in small seedlings soon after germination. It also occurs among the small seedlings of *Acacia mangium*, *Gmelina arborea* and *Paraserianthes falcataria*. The pathogen are *Rhizoctnia solani*, *Fusarium* spp., *Phytopthara* spp., and *Pythium* spp. Among the symptoms of the disease are types of rot at the root, root collar and top.

For prevention, soil that has been burned is used as the material soil in the sowing bed (direct sowing in pots), or the soil is disinfected.

When the young seedlings are found to have these symptoms, they should be sprayed using chemicals immediately to prevent further spreading.

o Charcoal rot (Anthracnose)

The symptoms of this disease frequently appear in times of high temperatures. Since the roots are affected, the seedlings shrink and eventually die. The pathogen is *Macrophomia* spp. *Acacia mangium* and *Paraserianthes falcataria* are susceptible to damage.

Shading and watering are effective countermeasures.

o Leaf spot

Dark brown spots appear on the surface of leaves. These spots become bigger, and the leaves turn yellow and fall. The pathogen are *Glomerella cingulata*, *Phyliosticitina* spp., *Phomopsis* spp., and *Pestalotiopsis* spp. *Acacia mangium* and *Paraserianthes falcataria* are susceptible to this disease.

For prevention, diseased leaves should be collected and burned; if there is a possibility of spreading, spraying should be carried out.

(2) Diseases in Plantations

o Die back disease

In this disease, leaves turn yellow and fall, branches are deformed, dark brown stigmata come out, and small black spots appear. This disease tends to break out in areas of poor soil or podzol, and is frequently found in *Acacia* spp. The pathogen are *Tremetes sacrosa* and *Basidiomycetes* spp.

To control it, diseased branches and plants should be burned. If the land is not well drained, drainage should be improved.

o Pink disease

The mycelium formed on the bark turns pink; or worse, the bark dies and peels off. If the branches are attacked by the pathogen, the affected parts wither, and the leaves shrivel and fall. The pathogen is *Corticium salmonicolor*. The symptoms are found among the *Acacia* and *Eucalyptus* spp., and *Paraserianthes falcataria*.

For prevention, dead and fallen branches and fallen leaves should first be collected and burned. Then, a copper compound should be sprayed on the trees and the soil surface.

5-4-2 Insect and Animal Control

(1) Insect and Animal Damage in the Nursery

o Rats (*Rattus argentiventer*)

Stems of the seedlings of *Acacia mangium* are attacked, often resulting in their death.

For prevention, areas around the nursery where rats inhabit should be cleared, and extermination using poisoned feed carried out.

o Slugs (*Vaginula*)

In a damp nursery at a high ground-water level, the buds of *Acacia mangium* are attacked, hindering growth and deforming and killing the seedlings.

For prevention, drainage should improved, and extermination carried out using a chemical spray.

o Leaf-eating insects

Larvae of butterfly attack the leaves and buds of *Acacia mangium* seedlings,

hindering growth and deforming the seedlings.

When the damage begins to spread, it should be controlled by exterminating using chemical sprays.

o Grasshoppers

The leaves of *Acacia mangium* are attacked by *Stenocatantops splendens* and *Attractomoropha psittacina*. Although there have been no cases of serious damage occurring, care should nevertheless be taken because, if an outbreak does happen, there is a possibility of total destruction.

(2) Insect and Animal Damage in Plantations

o Squirrels

Bark at the roots of *Acacia mangium* is stripped off, and if the damage is extensive, the tree will die. Damage has been minimum so far.

o Termites

Trees are attacked by *Coptotermes curvignathus, Macrotomes gigus,* and *Microcerotermes* spp. The attacked tree will sometimes die, and even if it does not, the timber will be of noncommercial value.

As the plantation is extended in the future, countermeasures against termites will be necessary. It is essential to detect the infested trees as soon as possible, then cut and burn them.

o Ants

Camponotus spp. settles in the trunk. Even if the damaged tree does not die, the commercial value of its timber will be lost. Once again, the infested trees should be detected as soon as possible, then cut and burn them.

o Long-horned beetles

Xystrocera festiva and *Lepidoptera* spp. attack the sapwood, making holes in the trunk and branches. The damaged tree rarely dies, but the commercial value of its timber will be reduced. *Paraserianthes falcataria* is most prone to attack. Early detection and eradication is essential.

5-5 Settlement Plan

5-5-1 Location of the Base and Management of the Settlement

As shown in Figure 3-3, the base will be located near the confluence of the Bengkoka and Mandamai Rivers for the reasons described in "3-3-1 Base Location".

Settlement will involve the following objectives:

- o Establishment of 400 houses.
- o Provision of settler's homes with electricity and water supply.
- o Provision of 0.1 hectares of land with each house to be tilled freely by the settlers.
- o Settlers will live primarily on the wages from re/afforestation work, but to stop the settlers from leaving the area and to encourage them to work harder, one-third of the net profit from timber harvesting will be distributed to each settler according to the number of shares.
- o One share will be given for each year when the total of working days exceed the percentage designated by the official in charge of operations.
- o The shares of each settler will be accumulated during 15 years from planting to harvesting year.
- o A communal farmland of 200 hectares will be rearranged by the third year from the start of planting work to be used by the settlers under proper instruction. The agroforestry system will be introduced.
- o The communal farmland should be provided within the base area.

5-5-2 Agroforestry System

Because the Bengkoka Afforestation and Settlement Project involves reafforestation to utilize settlers labor and future harvesting operations, an agroforestry system is necessary.

To begin with, agroforestry is taking place in various forms throughout the world. Many different kinds of agroforestry systems are being adopted, depending on natural considerations like climate, topography, soil, etc.; social and economic conditions such as level of development, ethnic customs, living standards, etc.; and the policy targets, or in

Table 5-16 Base Facilities Costs

(Unit: M$1,000)

Facilities \ Year	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th	16th	Total
Construction cost																	
Management facilities	270	100															370
Public facilities	1,160	670	320	110													2,260
Staff residences	1,300	240	210	50													1,800
Settlers' residences	4,455	660	405	495	495												6,600
Management vehicles & other equipment	70	245			23	70	210	9			79	210		9		70	995
Sub-total	7,255	1,915	1,025	655	518	70	210	9			79	210		9		70	12,025
Maintenance cost																	
Management facilities		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	150
Public facilities		130	130	180	180	190	190	190	190	190	190	190	190	190	190	190	2,710
Staff residences		30	40	50	50	50	50	50	50	50	50	50	50	50	50	50	720
Settlers' residences	40	46	51	55	60	60	60	60	60	60	60	60	60	60	60	60	912
Vehicles & other equipment	20	82.7	82.7	82.7	82.7	82.7	82.7	82.7	82.7	82.7	82.7	82.7	82.7	82.7	82.7	82.7	1,260.5
Sub-total	60	298.7	313.7	377.7	382.7	392.7	392.7	392.7	392.7	392.7	392.7	392.7	392.7	392.7	392.7	392.7	5,752.5
Total	7,315	2,213.7	1,338.7	1,032.7	900.7	462.7	602.7	401.7	392.7	392.7	471.7	602.7	392.7	401.7	392.7	462.7	17,777.5

other words, the objectives of agroforestry.

For example, the well-known agroforestry projects presently being undertaken in Southeast Asia are TUMPANG SARI of Indonesia, Forest Village of Thailand, Social Forestry of the Philippines, and the TAUNGYA System of Burma. In other areas, there are PANCHAYAT Forest (Community Forestry) of Nepal, and SHAMBA System of Kenya, while in Japan there has been KOBASAKU forestry (one variety of the TAUNGYA System) and transmigration to forest villages.

These forms of agroforestry can be roughly grouped into the following two types: which is itself a combination system of forestry and agriculture (including stock raising).

(1) An inter-cropping type: This type is a system of growing (raising) agricultural crops (livestock) among trees. This is a form in which forestry and agriculture (stock farming) coexist in the same area. Among the afore-mentioned examples, TUMPANG SARI, TAUNGYA System, SHAMBA System, and KOBASAKU forestry fall into this type.

(2) A block type: Forestry and agriculture (stock farming) constitute a single unit management even though they are geographically distant. Of the above-mentioned examples, this type is applied to one kind of Social Forestry, PANCHAYAT Forest, and Transmigration to forest villages. If forestry and agricultural stock farming is carried out by the family as the management unit, the area is divided into small parts; if the same activities are undertaken by the hamlet, the small catchment area is zoned into considerably larger parts.

By considering these different types, the agroforestry system for the project can be developed along the following lines:

An area of 0.1 hectare around settlers' houses will be used as a vegetable garden to grow food primarily for self-consumption. Therefore, tree planting, one component of agroforestry, is not expected to be carried out in this area except for some fruit trees or shade trees.

The two hundred hectare area of the communal farmland for agriculture and forestry to be established near the settlers' residential area should be utilized as a supply area fuel wood, fodder for cattle (tree leaves) and fruit. This will thus be the land used for

agroforestry of the block type mentioned above. Examples of this type of agroforestry are the TALUN and KEBUN systems of Java in Indonesia; and the common land of the cooperative re/afforestation project carried out in South Sumatra in cooperation between the Republic of Indonesia and Japan.

No early decision can be made as to whether agroforestry should be introduced within the afforested area of this project. The reason is that the agroforestry system in re/afforested areas takes the form of inter-cropping, and there are doubts about the feasibility of the intercropping of farm products in an area re/afforested with fast growing and heavy shading *Acacia mangium*.

Experiments should therefore be carried out beforehand on inter-cropping in the re/afforested area, with the period of intercropping being possibly one or two years after tree planting. The farm products will be shade-tolerant root plants. In line with these ideas, the agroforrestry plan for each division is shown below.

Agroforestry System

Land Division	Plants
Land attached to each house; vegetable garden (0.1 ha per household)	Leafty plants, stem plants, fast growing fruit trees (banana, papaya, etc.) for the settlers
Common farmland for agriculture & forestry (200 ha)	Fuel wood (Casuarina, Glerecidae, Sesbania, etc.), fodder trees (Calliandro, Leucaena, etc.) fruit trees (durian, manggis, mangga, rambutan, cashew, cocopalm, coffee tree, etc.), and pasture (Pennisetum, Setaria, Panicum, etc.)
Reafforested area	Between 1–2 years after tree planting: tolerant root plants, etc.

5-5-3 Base Facilities

Base facilities will be built on either side of the Mandamai River. The facilities will be grouped in the following three blocks for ease of management.

o Management block

Management facilities, with a management office as the central building, and such general facilities as a generating plant, water supply system, and a guest house will be built for the settlers and the management staff.

Figure 5-1 Illustration of the Base

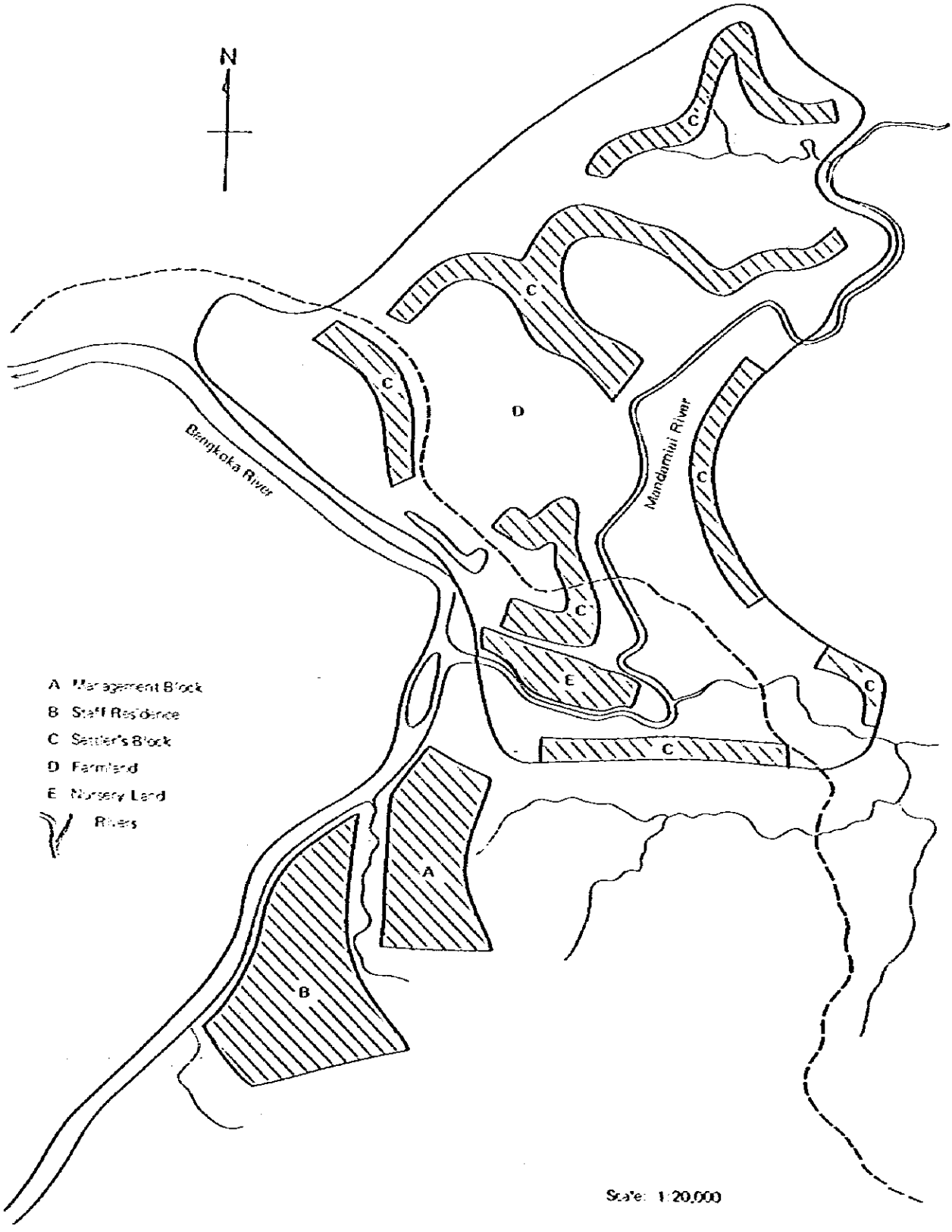


Table 5-17 Management Facilities Cost

(Unit: M$1,000)

Year	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th	16th	Total
Land clearing	80																80
Construction cost																	
Administration office	150																150
Garage		20															20
Repair shop		20															20
Store		30															30
Warehouse		30															30
Sub-total	150	100															250
Equipments	40																40
Total	270	100															370
Maintenance cost		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	150
Grand total	270	110	10	10	10	10	10	10	10	10	10	10	10	10	10	10	520

This will be situated in the center of the base, to the south of the Mandamai River.

- Staff residence block

  This will be located to the south of the management block, the houses for management staff.

- Settlers' block

  Houses for the settlers will be constructed in this block north and south of the Mandamai River.

5-5-4 Public Facilities

- Electricity

  Electricity, generated with two Diesel generators (250 KVA), will be supplied to each house.

- Water supply

  Water will be obtained from the Bengkoka River, sent to the storage tank on top of the hill 75 meters above sea-level by a 1,000 m-long pipe, and supplied to each house by natural flow. Total water demand is estimated at 250 kiloliters per day.

- Sewerage system — A small purifier will be built.
- Guest house — One guest house also serving as a meeting place will be built.
- Chapels — One chapel and one surau o School One primary school
- School — One primary school
- Clinic — One clinic
- Playground — One soccer field

Construction and maintenance costs for the facilities are shown in Table 5-18.

5-5-5 Staff Residences

- A-class residences (120 square meters) for the project manager and senior research officer (two)
- B-class residences (100 square meters) for officials and research staff (six)
- C-class residences (70 square meters) for assistant officials and school teachers (eighteen)
- D-class residences (50 square meters) for other staff members (thirteen)

Table 5-18 Public Facilities Cost

(Unit: M$1,000)

Year	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th	16th	Total
Construction cost																	
Electricity equipment	220	40	220	20													500
Water supply	600	100	50	50													800
Sewerage system	340	70	50	40													500
Guest house		100															100
Chapel & Surau		50															50
School		200															200
Clinic		100															100
Playground		10															10
Sub-total	1,160	670	320	110													2,260
Maintenance cost																	
Electricity equipment		100	100	150	150	150	150	150	150	150	150	150	150	150	150	150	2,150
Others		30	30	30	30	40	40	40	40	40	40	40	40	40	40	40	560
Sub-total		130	130	180	180	190	190	190	190	190	190	190	190	190	190	190	2,710
Total	1,160	800	450	290	180	190	190	190	190	190	190	190	190	190	190	190	4,970

Table 5-19 Staff Residences Cost

(Unit: MS1,000)

Year			1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th	16th	Total
Construction cost		Unit cost																	
		No.																	
A class		2	100	200															200
B class		6	80	480															480
C class		17*	50	500	150	150	50												850
D class		9	30	120	90	60													270
Sub-total				1,300	240	210	50												1,800
Maintenance cost					30	40	50	50	50	50	50	50	50	50	50	50	50	50	720
Total				1,300	270	250	100	50	50	50	50	50	50	50	50	50	50	50	2,520

*include 2 teacher houses

Table 5-20 Settlers' Residences Cost

(Unit: MS1,000)

Year		1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th	16th	Total
Number of constructions		270	40	30	30	30												400
Construction cost	Unit cost																	
Residence	15	4,050	600	450	450	450												6,000
Roads & other facilities	1.5	405	60	45	45	45												600
Sub-total		4,455	660	495	495	495												6,600
Maintenance cost		40	46	51	55	60	60	60	60	60	60	60	60	60	60	60	60	912
Total		4,495	706	546	550	555	60	60	60	60	60	60	60	60	60	60	60	7,512

5-5-6 Settlers' Residences

Because the settlers are composed of people of different races and religions, care should be taken so that troubles arising from religious and cultural differences can be avoided.

In locating the settlers' residences, therefore, it is preferable to construct a small village with people from the same hometown. The land area per household will be 0.1 hectares including 50 square meters for the house, and the settlers will be allowed to undertake self-sufficient cultivation there.

The total number of the residences will be 400. Considering the number of workers needed for the re/afforestation work, housing construction should be done in the following schedule:

First year: 270 houses

Second year: 40 houses

From the third year through the fifth year: 30 houses per year

5-6 Administration Plan

5-6-1 Organization

The Division V administration office will be established to administer all affairs under the direction of the General Manager of SAFODA. In order to administer the affairs smoothly and ensure successful operation, an adviser with sufficient knowledge and experience should be employed. The Division V administration office will have the following sections: Administrative, Settlement, and Plantation, with sub-sections in each.

Further, a silviculture research center is to be established to conduct research activities necessary for the re/afforestation project. The organization and the number of the staff are shown in Table 5-22.

The duties involved in each position in the management office of Division V are as follows:

Table 5-21 Vehicles and Other Facilities Cost

(Unit: M$1,000)

Year		1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th	16th	Total
	Unit cost																	
Vehicles																		
Purchase cost																		
Wagons 4WD (8)	35	70	210				70	210				70	210				70	910
Maintenance cost	10	20	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	1,220
Sub-total		90	290	80	80	80	150	290	80	80	80	150	290	80	80	80	150	2,130
Fire prevention																		
Construction of watchtowers (5)	2		6			4												10
Communication facilities (6)	5		20			10												30
Motor bikes (3)	3		9			9			9			9			9			45
Facilities total			35			23			9			9			9			85
Operation cost			2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	40.5
Workers (5)	3.84		11.52	11.52	11.52	19.2	19.2	19.2	19.2	19.2	19.2	19.2	19.2	19.2	19.2	19.2	19.2	264.96
Sub-total			49.22	14.22	14.22	44.9	21.9	21.9	30.9	21.9	21.9	30.9	21.9	21.9	30.9	21.9	21.9	390.46
Total		90	339.22	94.22	94.22	124.9	171.9	311.9	110.9	101.9	101.9	180.9	311.9	101.9	110.9	101.9	171.9	2,520.46

Table 5-22 Organizational Structure and Staff

Section	Title	Number	Remarks
Division V	Division V Project Manager	1	
Administration Office	Technical Adviser	1	
Administration Section	Administration Officer	1	
General Affairs	Executive Officer	1	
	Secretary to Project Manager	1	
	Typist	1	
Accounts	Accounting Officer	1	
	Accountant	1	
Forest Road	Forest Road Specialist	1	
Protection	Protection Officer	1	
Mechanics	Senior Superintendent Mechanicer	1	
	Technical Assistant	1	
Settlement Section	Settlement Officer	1	
Settlement	Assistant Settlement Officer	1	
Facilities	Engineering Assistant	1	
Agriculture	Agriculturist	1	
	Assistant Agriculturist	1	
Plantation Section	Plantation Officer	1	
Plantation	Assistant Plantation Officer	3	One officer per parcel
	Field Assistant	3	One officer per parcel
Nursery	Nursery Officer	1	In charge of nursery and materials
	Assistant Nursery Officer	1	
Planning & Mapping	Surveyor (Planning & mapping specialist)	1	
	Assistant Surveyor	1	
Division V Silviculture Research Center	Division V Senior Research Officer	1	
Nursery Research	Research Officer (Breeding)	1	
	Assistant Research Officer (Breeding)	1	
Plantation Research	Research Officer (Planting)	1	
	Assistant Research Officer (Planting)	1	
Total		33	

1) Project Manager;

Administers Division V under the direction of the General Manager of SAFODA.

2) Technical Adviser;

Advises the Project manager on the administration of Division V in accordance with the basic policy of the Bengkoka Project, and undertakes the task of guidance for the operation.

3) Senior Administrative Officer;

Responsible to the project Manager for the supervision of Administration, Accounting, Prevention, Road and Mechanical sections, and communicates and coordinates with all officers.

- o Supervisors, Specialist and Engineer: carry out the responsibilities of their respective sections under the direction of the Senior administrative officer. (Will also supervise any staff under them.)
- o Staff member: carries out the responsibilities of his section under the direction of the assistant officer.

4) Senior settlement officer

Responsible for the Supervision of Settlement, Agriculture, and Civil Engineering sections under the direction of the Project Manager, and oversees the general affairs of each section.

- o Supervisors and Engineers: carry out the responsibilities of their sub-sections under the direction of the Senior settlement officer, and supervise the staff members.
- o Staff members: undertake field work under the direction of the supervisor.

5) Senior re/afforestation officer

Responsible for the supervision of re/afforestation, seed management, and nursery under the direction of the Project Manager, and oversees the general affairs of each subsection. To implement the re/afforestation as a basic operation of this project, he should pay particularly attention to the supervision of the field works. He should communicate and coordinate with each officer on the advice of the Technical adviser.

- o Supervisor: carries out responsibilities of his sub-section and supervises site work under the supervision of the Senior re/afforestation officer.
- o Re/afforestation engineer, Assistant for seed management and nursery works: carries out the clerical work related to field work under the directions of supervisor.

6) Senior research officer

Administers the silviculture research center on the advice of Division V project manager, and the Technical adviser. He should coordinate with the senior research officer of SAFODA.

7) Research officers

Conduct investigation and research needed for the project under the direction of the Senior research officer, and supervise the assistant research officers.

- Assistant research officers: carry out investigation and research in their section under the direction of the research officers.

8) Surveyor

Makes project plans under the direction of the Project Manager, and directs the assistant surveyor.

- Assistant surveyor: works under the direction of the surveyor.

5-6-2 Administration and Management

When carrying out the modified plan, suitable technology should be employed, but what is more important is efficient administration and management. Establishment of a proper organization and its smooth operation would, therefore, be essential.

In this regard, we recommend the following operational principles to ensure efficiency of the project:

1) Each officer should fully understand the content of his work so that he can work on his own initiative.
2) Senior staff should give clear instruction and guidance to subordinates and monitor their activities.
3) Close contact should be maintained among all staff
4) The activities of the whole project should always be made known to every officer.

By taking these factors into consideration, the whole organization is expected to acquire a sense of unity, or esprit de corp.

On the other hand, it is necessary to urge not only a further development of the forest policy to support the project, but also the advancement of social and economic policies

such as welfare, industry and public works which would also enhance the project activities in the broader frame work. Also, as a means of reinvesting the earnings from the forest back into the forest projects in Sabah, this type of project should be promoted throughout the State so that its significance and advantages can be fully appreciated.

Although the settlers are not included in the organization of the management office, they have an important role that is likely to determine the success of the project; therefore, it is no exaggeration to say that the settlers and the management constitute a community bound together by common fate.

Although the settlers receive wages for their work to maintaining themselves, the income from agriculture they will be engaged in must not be overlooked. This project is more or less one in which forestry and agriculture are combined, and sometimes the aims of each may be in conflict. If this happens, as long as forestry management is not significantly interfered with, the basic policy for settlement should be to place importance on agriculture as a means of stabilizing the workers' livelihood.

5-6-3 Administration and Management Cost

The expenditure required for administration and management, such as salaries for administration and management staff, are shown in Table 5-23.

5-7 Financial Analysis

5-7-1 The Method of Financial Analysis in the Modified Plan

To examine the feasibility of the modified plan, financial and economic analyses are of extreme importance, in addition to the examination of the physical implementation plan and schedule for re/afforestation and settlement.

The project has two aspects: commercial and social. The former involves re/afforestation, with the aim of earning sales income from harvested timber in order to meet the costs incurred by the implementation of the project, and, subsequently, to achieve pro-

Table 5-23 Staff Salaries and Their Assumption of Offices

Position	Salary M$1,000	Number of Officers				
		1st year	2nd year	3rd year	4th year	Thereafter
Project Manager	60	1	1	1	1	1
Technical Adviser (till 25th year)	150	1	1	1	1	1
Senior Research Officer	45	0	1	1	1	1
Administration Officer	35	1	1	1	1	1
Settlement Officer	35	1	1	1	1	1
Plantation Officer	35	0	1	1	1	1
Surveyor	35	1	1	1	1	1
Research Officer	35	0	2	2	2	2
B Class Total		3	6	6	6	6
Executive Officer	30	1	1	1	1	1
Accounting Officer	30	1	1	1	1	1
Forest Road Specialist	30	1	1	1	1	1
Protection Officer	30	0	1	1	1	1
Senior Superintended Mechanicer	30	1	1	1	1	1
Assistant Settlement Officer	30	0	0	1	1	1
Engineering Assistant	30	1	1	1	1	1
Agriculturist	30	0	1	1	1	1
Assistant Plantation Officer	30	0	0	1	2	3
Nursery Officer	30	1	1	1	1	1
Assistant Surveyor	30	0	0	1	1	1
Assistant Research Officer	30	0	0	0	2	2
C Class Total		6	8	11	14	15
Secretary	25	1	1	1	1	1
Accountant	25	0	0	0	1	1
Technical Assistant	25	0	0	1	1	1
Assistant Agriculturist	25	0	0	1	1	1
Field Assistant	25	0	1	2	3	3
Assistant Nursery Officer	25	1	1	1	1	1
D Class Total		2	3	6	8	8
Typist	10	1	1	1	1	1
Total		14	21	27	32	33

(Management Staff Salary Total)

Position		1st year	2nd year	3rd year	4th year	Thereafter
	Unit Cost					
Project Manager	50	50	50	50	50	50
Technical Adviser	150	150	150	150	150	150
Senior Research Officer	45	0	45	45	45	45
B Class Staff	35	105	210	210	210	210
C Class Staff	30	180	240	330	420	450
D Class Staff	25	50	75	150	200	200
Typist	10	10	10	10	10	10
Subtotal		545	780	945	1,085	1,115
Casual Workers	3.84	11.52	11.52	11.52	11.52	11.52
Total		556.52	791.52	956.52	1,096.52	1,126.52

fits. The latter is concerned with settlement, from which indirect economic benefits can be expected, because investment is made with no direct profit making objectives according to the priority of public investment required by the whole nation.

Of total outlays in the modified plan, the cost of the social infrastructure involving schools, power and water supply is essentially to be borne by the relevant government agencies. Judging from the situation outlined in Section 2 "Background to the Project", if the modified plan is not implemented, it can be assumed that such elements of the infrastructure would be provided on a very small scale, ranking very low in the order of implementation priority. On the other hand, enormous developmental benefits are likely if the modified plan implemented with these elements of infrastructure. The costs of improving the infrastructure, in principle, have to be borne by SAFODA, for the time being, even if the relevant government agencies take responsibility for it in the future.

For this reason, the modified plan requires considerable funding. From the point of view of the whole plan, the outlays for the social infrastructure have to be borne by timber sales, but it will take a long time to recover the initial investment because of the unique characteristics of re/afforestation. It was, therefore, determined that the following analysis procedure be adopted.

- Confirm the feasibility by analyzing the direct components of re/afforestation.
- Assess how profits from re/afforestation can contribute to the success of the whole plan by calculating funds required for the modified plan. In other words, infrastructure for settlers life is regarded as public investment (as previously mentioned), and accordingly, the modified plan will be assessed by regarding the re/afforestation plan as being a separate entity, on the assumption that the plan will incur costs regardless of the re/afforestation plan.

5-7-2 Cost Estimates in the Modified Plan

The cost estimates were made based on the implementation plan under the following conditions:

- Prices are assessed in Malaysian Ringgit (M$) in 1984. The unit price of each item was estimated on the basis of the survey conducted in Sabah State. The prices of the items that were not available were estimated.

- The assessment period was set at fifty years from the commencement of the project. After fifty years, the second cycle for the whole of the projected land, and part of the third cycle will have finished, because the re/afforestation cycle is fifteen years.
- The residual value in the fiftieth year (the final assessment time) is not assessed because some problems remain in the methodology.
- SAFODA—the implementation agency—is a government body and thus has no tax imposed on it.
- The total expenditure calculated in the implementation plan includes price and physical contingencies. The price contingency account for 6%. In the calculation for the first year the rate of price contingency is not considered and for the following years the amount is calculated at the above rate. The physical contingency is assumed at 10%.
- Volume of harvest

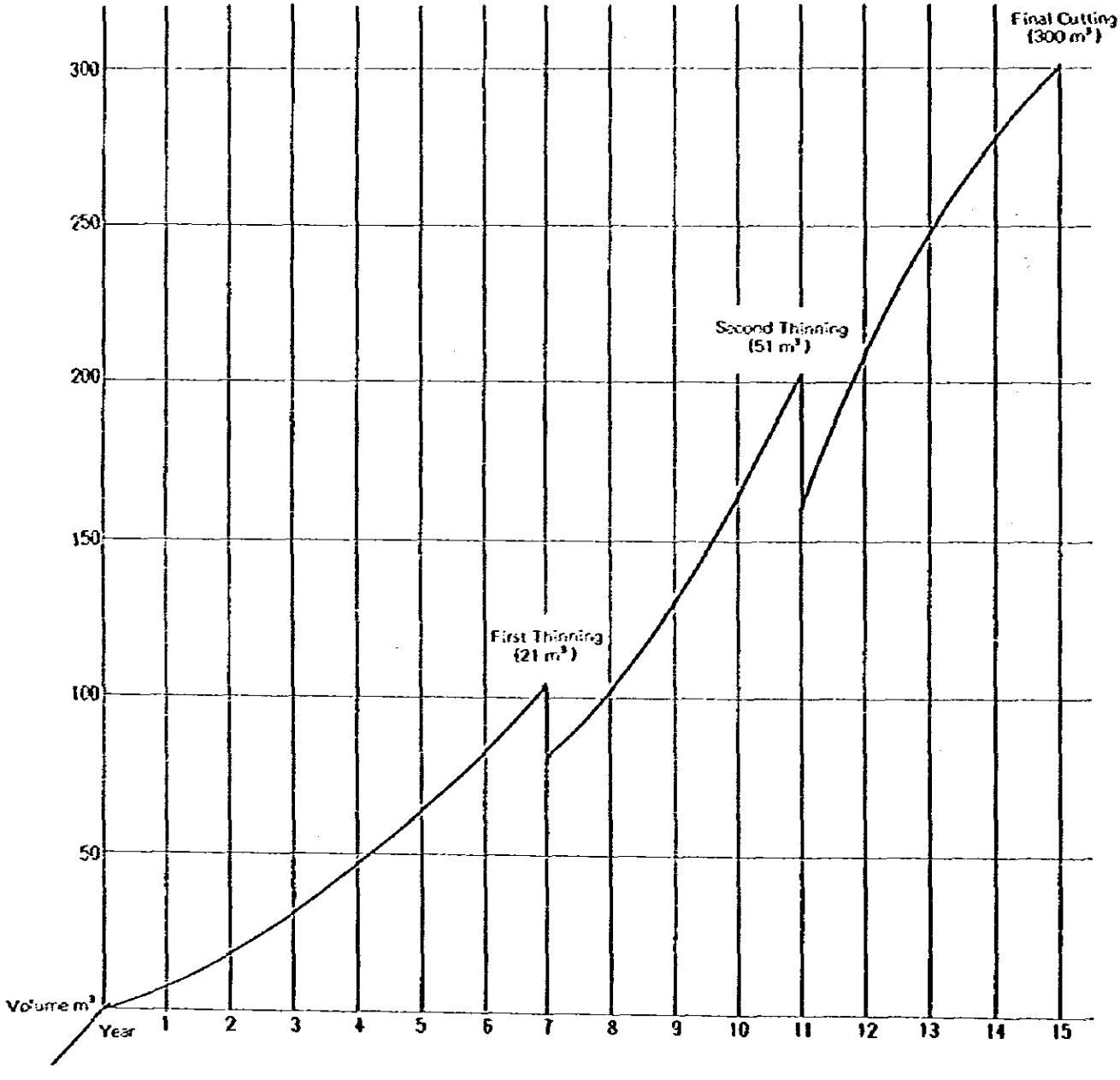
  Under the modified plan, the rotation age of *Acacia mangium*, which will account for the majority of timber to be produced in the future, is fifteen years and the harvesting volume was estimated at 300 m^3 per ha, based on survey results of existing re/afforestation and other available data. In comparison with the original plan, in which the volume was estimated at 254 m^3 per ha at age of twelve years, this estimate volume represents a safe and realistic amount judging from the growth expectations shown in Figure 5-2.

  Thinning volume was estimated at 21 m^3 per ha for the first thinning (in the seventh year) and at 51 m^3 per ha for the second thinning (in the eleventh year). Although it is not entirely appropriate to refer to an increase or decrease in the estimated thinning volume compared with the original plan because thinning volume depends on the intensity of thinning, it is obvious that the volume has not been overestimated in the modified plan, whereas in the original plan the volume of the first thinning (in the fifth year) was estimated at 14 m^3 and that of the second thinning (in the eighth year) at 39 m^3.
- Log usage

  In the modified plan, at the first thinning, all logs will be used for pulpwood, and at the second thinning, 70% will be used for pulpwood and the remaining 30% used for block board. At the time of final cutting, 40% of logs will be used for pulpwood, 30% for block board, and 30% for plywood (as shown in Table 5-24).

  These figures, conservatively estimated to avoid overestimating, are based on the

Figure 5-2 Shifts in Acacia mangium Growing Stock (per hectare)



Note: The above figures are average estimates obtained from the man-made forest survey and previous data.

Table 5-24 Revenue Estimates

(1) Returns from Log Sales

	Cutting Volume per ha (m^3)	Cutting Volume per 600 ha (m^3)	Uses (%)			Uses (m^3)		
			Chips	Block Board	Plywood	Chips	Block Board	Plywood
First Thinning	21	12,600	100	0	0	12,600	0	0
Second Thinning	51	30,600	70	30	0	30,600	9,180	–
Final Cutting	300	180,000	40	30	30	72,000	54,000	54,000

	Sales (M$1,000)				Logging Cost		Sales Return (M$1,000)
	Chips M$60 (Unit price)	Block Board M$80 (Unit price)	Plywood M$100 (Unit price)	Total Sales	Unit Price (M$)	(M$1,000)	
First Thinning	756	–	–	756.0	25	315.0	441.0
Second Thinning	1,285.2	734.4	–	2,019.6	25	765.0	1,254.6
Final Cutting	4,320.0	4,320.0	5,940.0	14,580.0	30	5,400.0	9,180.0

(2) Return from Charcoal Sales

Volume of Logs Used per ha (m^3)	Volume of Logs Used per 180 ha (m^3)	Weight (0.8 t/1 m^3) of Logs Used per 180 ha (ton)	Proportion by Quality (%)			Proportion by Quality (ton)		
			High Quality	Average Quality	Industrial use Quality	High Quality	Average Quality	Industrial use Quality
80	14,400	11,520	20	30	50	276.5	414.7	691.2

	Sales (M$1,000)				Charcoal-making Cost		Sales Return (M$1,000)
	High Quality M$800 (Unit price)	Average Quality M$600 (Unit price)	Industrial use Quality M$400 (Unit price)	Total Sales	Unit Price (M$)	Amount (M$1,000)	
Amount	221.20	248.82	276.43	746.50	351.00	485.28	261.22

Note: Carbonization Ratio : 12%

original plan and the demand projections for each item, on the world-wide and regional basis outlined in Appendix 7 "Projections of Timber Demand".

(In the original plan, all the logs produced from the first thinning will be used for pulpwood, and at the second thinning 60% will be used for pulpwood and the remaining 40% will be used for sawtimber. At the final cutting, 60% of the logs will be exported, 30% will be used for sawtimber, and the remaining 10% will be used for pulpwood.)

o Selling prices

In the modified plan, selling prices were estimated at M$60 per m^3 for pulpwood logs, M$80 for block board logs, and M$110 per m^3 for plywood logs.

The market prices of *Acacia mangium* have not been established. However, *Mangrove* logs for pulpwood are sold at M$85 per ton by FOB in Sabah, and therefore the selling prices of pulpwood logs were estimated by comparing the specific gravity *Mangrove* and *Acacia mangium*. The estimates for block board logs were made on the basis of the existing price of M$70-85 per m^3 for *Paraserianthes falcataria* logs set by FOB. The selling prices of plywood logs were estimated by considering the difference in quality between *Paraserianthes falcataria* and *Acacia mangium*, since *Paraserianthes falcataria* logs with diameters of 30 cm or more are sold at M$80 per m^3 by FOB.

o Logging costs

While logging costs were estimated at M$14-18 per m^3 in the original plan, they have revised upward to M$30 per m^3 in the modified plan. For thinning, the costs were estimated at M$25 per m^3 because the cost for cutting was included in re/afforestation costs.

5-7-3 Revenue and Outlays in the Modified Plan and FIRR

o Revenue

The revenue is expected to be generated from the sales of charcoal, the first thinning starting from the nineth year, the second thinning starting from the thirteenth year, and final cutting starting from the seventeenth year. The estimated yearly revenue during the seven-year period from the second year to the eighth is M$746,500; M$1,187,500 annually in the period between the nineth year and twelfth; M$2,442,100 annually in the period between the thirteenth year and the sixteenth; M$10,875,600 annually thereafter.

If the annual revenue figures are adjusted for an inflation rate of 6% (the same as that used for adjusting the annual outlay figure), the figures in nominal terms are as shown in Table 5-27.

As the table shows, the aggregated revenue for the fifty-year period amounts to M$2,915 million.

o Outlays

The aggregated costs involved in the fifty years of the project on the basis of the implementation plan amount to M$208.8 million (US$90.8 million), of which 25.7% is the foreign portion. The combined outlays for forest road construction, nursery, re/afforestation, and charcoal production amounts to M$117.7 million, accounting for 56.4% of the total costs. If the administrative costs are added to the combined outlays, the resultant outlay involved in SAFODA's operations amounts to M$174.6 million, or 83.6% of M$208.8 million.

Thus, the remaining M$34.2 million, or 16.4% of M$208.8 million will be used to cover the outlay for the preparation and improvement of the social infrastructure of the community. However, as the figures are calculated on a long-term basis of fifty years and the operational cost accounts for a large portion of the total expenditure, the proportion of the outlays that can be allotted to consolidation of the social infrastructure will tend to be relatively small.

As shown in Tables 5-25 and 5-26, the total outlays including the allowances for price fluctuations and physical contingencies are M$1,250.1 million.

Higher levels of expenditure mainly occur at the time of initial investment and at the time when rebuilding of houses becomes necessary every twenty years.

o Outlays and Financial Internal Rate of Return

The annual revenue and expenditure are shown in Table 5-28. The annual balance will be in the black for the first time in the seventeenth year when harvesting is commenced. The cumulative deficit will peak at M$96.2 million in the sixteenth year, but will disappear by the twenty-second year, resulting in the FIRR being 11.5%.

The FIRR resulting from SAFODA's operations amounts to 13.7%, if the expenditure on the community, which should be borne by other government agencies, is deducted from the total expenditure.

Table 5-25 Summary of Expenditure

	M$ million			Foreign Currency Ratio (%)	Composition (%)	US$ million		
	Domestic	Foreign	Total			Domestic	Foreign	Total
Forest Road	7.7	24.7	32.4	76.2	15.5	3.4	10.7	14.1
Nursery	11.7	2.6	14.3	18.2	6.8	5.1	1.1	6.2
Afforestation Work	46.5	11.3	58.0	19.5	27.8	20.2	4.9	25.2
Charcoal Production	13.1	0.0	13.1	0.0	6.3	5.7	0.0	5.7
Sub-Total (A)	79.0	38.6	117.7	32.8	56.4	34.3	16.8	51.2
Administration (B)	52.0	4.9	56.9	8.6	27.3	22.6	2.1	24.7
SAFODA (A) + (B)	131.0	43.5	174.6	24.9	83.6	57.0	18.9	75.9
Community	18.5	15.7	34.2	45.9	16.4	8.0	6.8	14.9
Total	149.6	59.2	208.8	28.4	100.0	65.0	25.7	90.8
Price Contingencies	666.0	261.7	927.7	—	—	289.6	113.8	403.3
Physical Contingencies	—	—	113.6	—	—	—	—	49.4
Total Outlays	—	—	1,250.1	—	—	—	—	543.5

Note: The total is not necessarily consistent as a result of rounding figures.
Exchange rate used: M$2.3 = US$1 (See Appendix)

Table 5-26 Annual Expenditure

(M$1,000)

Year	Base Cost			Price Contingencies			Physical Cont.	Total Outflow
	Total	Foreign	Local	Foreign	Local	Total		
				0.060	0.060		0.100	
1	7,840.6	3,362.5	4,478.0	0.0	0.0	0.0	784.1	8,624.6
2	4,902.4	1,715.7	3,186.7	102.9	191.2	294.1	519.7	5,716.2
3	4,533.4	1,284.3	3,249.1	158.7	491.6	650.3	509.4	5,693.1
4	4,460.6	1,072.1	3,388.6	204.8	647.3	852.0	531.3	5,843.9
5	4,825.2	1,282.3	3,542.9	336.6	929.9	1,266.5	609.2	6,700.8
6	4,607.5	1,358.2	3,249.3	459.4	1,099.0	1,558.3	616.6	6,782.4
7	4,674.4	1,431.6	3,242.8	599.1	1,357.1	1,956.3	663.1	7,293.7
8	4,216.4	865.6	3,350.8	435.9	1,687.5	2,123.4	634.0	6,973.8
9	4,511.4	1,106.6	3,404.8	657.1	2,021.9	2,679.0	719.0	7,909.4
10	4,261.4	856.6	3,404.8	560.6	2,347.5	2,908.1	719.9	7,919.3
11	4,902.0	1,467.2	3,434.8	1,160.3	2,716.4	3,876.7	877.9	9,656.5
12	4,759.9	1,331.6	3,428.3	1,196.1	3,079.6	4,275.7	903.6	9,939.1
13	4,621.3	1,106.6	3,514.7	1,120.0	3,557.5	4,677.5	929.9	10,228.7
14	4,380.3	865.6	3,514.7	989.6	3,931.8	4,962.4	934.3	10,277.0
15	4,471.3	956.6	3,514.7	1,206.1	4,431.6	5,637.7	1,010.9	11,119.9
16	4,579.4	1,208.2	3,371.2	1,681.3	4,708.0	6,395.3	1,097.5	12,072.1
17	3,934.3	1,440.6	2,493.7	2,218.9	3,841.1	6,060.1	999.4	10,993.8
18	3,200.3	706.6	2,493.7	1,196.0	4,221.2	5,417.3	851.8	9,479.3
19	3,300.3	806.6	2,493.7	1,495.6	4,624.1	6,119.7	942.0	10,362.0
20	3,209.3	715.6	2,493.7	1,443.4	5,051.2	6,500.6	971.0	10,680.9
21	8,746.7	2,982.9	5,763.8	6,583.5	12,721.2	19,304.7	2,805.1	30,856.6
22	4,341.3	1,393.4	2,947.9	3,343.4	7,073.5	10,416.9	1,475.8	16,234.1
23	3,804.3	973.1	2,831.2	2,533.4	7,371.0	9,904.4	1,370.9	15,079.5
24	3,695.3	864.1	2,831.2	2,436.4	7,983.1	10,419.5	1,411.5	15,526.3
25	3,949.3	1,115.3	2,834.0	3,400.3	8,640.5	12,040.8	1,599.0	17,589.1
26	3,717.5	1,217.2	2,500.2	4,006.8	8,230.2	12,237.0	1,596.4	17,549.9
27	3,775.3	1,281.6	2,493.7	4,543.7	8,850.9	13,394.6	1,717.5	18,892.4
28	3,200.3	706.6	2,493.7	2,700.7	9,531.6	12,232.3	1,543.3	16,975.9
29	3,459.3	965.6	2,493.7	3,970.0	10,253.1	14,223.1	1,768.2	19,450.7
30	3,200.3	706.6	2,493.7	3,121.8	11,017.9	14,139.7	1,734.0	19,074.0
31	3,808.5	1,308.2	2,500.2	6,205.2	11,859.5	18,064.7	2,187.3	24,060.5
32	3,684.3	1,190.6	2,493.7	6,057.6	12,687.9	18,745.5	2,243.0	24,672.8
33	3,450.3	956.6	2,493.7	5,216.4	13,598.8	18,815.2	2,226.5	24,492.0
34	3,200.3	706.6	2,493.7	4,126.7	14,564.3	18,691.0	2,189.1	24,080.4
35	3,309.3	815.6	2,493.7	5,093.0	15,587.8	20,680.8	2,399.5	26,389.6
36	3,708.5	1,208.2	2,500.2	8,077.8	16,716.2	24,794.1	2,850.3	31,352.8
37	3,925.3	1,431.6	2,493.7	10,231.4	17,822.6	28,054.1	3,197.9	35,177.3
38	3,209.3	715.6	2,493.7	5,464.0	19,041.6	24,505.6	2,771.5	30,456.4
39	3,300.3	806.6	2,493.7	6,576.7	20,333.7	26,910.4	3,021.1	33,231.8
40	3,200.3	706.6	2,493.7	6,143.4	21,703.3	27,852.8	3,105.3	34,158.4
41	8,755.7	2,991.9	5,763.8	27,780.8	53,519.1	81,299.9	9,005.6	99,061.2
42	4,341.3	1,393.4	2,947.9	13,797.8	29,191.7	42,989.5	4,733.1	52,063.9
43	3,795.3	964.1	2,831.2	10,177.3	29,888.1	40,065.4	4,386.1	48,246.8
44	3,704.3	873.1	2,831.2	9,822.1	31,851.2	41,673.3	4,537.8	49,915.4
45	3,949.3	1,115.3	2,834.0	13,366.5	33,965.7	47,332.2	5,128.1	56,409.6
46	3,708.5	1,208.2	2,500.2	15,421.5	31,913.2	47,334.7	5,104.3	56,147.5
47	3,784.3	1,290.6	2,493.7	17,533.7	33,893.4	51,428.1	5,521.2	60,733.7
48	3,200.3	706.6	2,493.7	10,220.8	36,072.4	46,293.2	4,949.3	54,442.8
49	3,450.3	956.6	2,493.7	14,724.7	38,386.3	53,111.0	5,656.1	62,217.4
50	3,209.3	715.6	2,493.7	11,718.7	40,839.1	52,557.8	5,576.7	61,343.8
Total	208,774.4	50,207.8	149,566.9	261,671.9	665,939.5	927,671.9	113,644.6	1,250,090.9

Table 5-27 Annual Revenue

(M$1,000)

Year	Charcoal	1st Thinning	2nd Thinning	Final Cutting	Total (Real)	Total (Nominal)
1	0.0	0.0	0.0	0.0	0.0	0.0
2	746.5	0.0	0.0	0.0	746.5	791.3
3	746.5	0.0	0.0	0.0	746.5	838.8
4	746.5	0.0	0.0	0.0	746.5	889.1
5	746.5	0.0	0.0	0.0	746.5	942.4
6	746.5	0.0	0.0	0.0	746.5	999.0
7	746.5	0.0	0.0	0.0	746.5	1,058.9
8	746.5	0.0	0.0	0.0	746.5	1,122.5
9	746.5	441.0	0.0	0.0	1,187.5	1,892.7
10	746.5	441.0	0.0	0.0	1,187.5	2,006.2
11	746.5	441.0	0.0	0.0	1,187.5	2,126.6
12	746.5	441.0	0.0	0.0	1,187.5	2,254.2
13	746.5	441.0	1,254.6	0.0	2,442.1	4,913.9
14	746.5	441.0	1,254.6	0.0	2,442.1	5,208.8
15	746.5	441.0	1,254.6	0.0	2,442.1	5,521.3
16	746.5	441.0	1,254.6	0.0	2,442.1	5,852.6
17	0.0	441.0	1,254.6	9,180.0	10,875.6	27,627.4
18	0.0	441.0	1,254.6	9,180.0	10,875.6	29,285.0
19	0.0	441.0	1,254.6	9,180.0	10,875.6	31,042.1
20	0.0	441.0	1,254.6	9,180.0	10,875.6	32,904.6
21	0.0	441.0	1,254.6	9,180.0	10,875.6	34,878.8
22	0.0	441.0	1,254.6	9,180.0	10,875.6	36,971.5
23	0.0	441.0	1,254.6	9,180.0	10,875.6	39,189.8
24	0.0	441.0	1,254.6	9,180.0	10,875.6	41,541.1
25	0.0	441.0	1,254.6	9,180.0	10,875.6	44,033.5
26	0.0	441.0	1,254.6	9,180.0	10,875.6	46,675.5
27	0.0	441.0	1,254.6	9,180.0	10,875.6	49,476.0
28	0.0	441.0	1,254.6	9,180.0	10,875.6	52,444.5
29	0.0	441.0	1,254.6	9,180.0	10,875.6	55,591.1
30	0.0	441.0	1,254.6	9,180.0	10,875.6	58,926.6
31	0.0	441.0	1,254.6	9,180.0	10,875.6	62,462.0
32	0.0	441.0	1,254.6	9,180.0	10,875.6	66,209.7
33	0.0	441.0	1,254.6	9,180.0	10,875.6	70,182.2
34	0.0	441.0	1,254.6	9,180.0	10,875.6	74,393.1
35	0.0	441.0	1,254.6	9,180.0	10,875.6	78,856.6
36	0.0	441.0	1,254.6	9,180.0	10,875.6	83,587.9
37	0.0	441.0	1,254.6	9,180.0	10,875.6	88,603.1
38	0.0	441.0	1,254.6	9,180.0	10,875.6	93,919.2
39	0.0	441.0	1,254.6	9,180.0	10,875.6	99,554.2
40	0.0	441.0	1,254.6	9,180.0	10,875.6	105,527.4
41	0.0	441.0	1,254.6	9,180.0	10,875.6	111,858.9
42	0.0	441.0	1,254.6	9,180.0	10,875.6	118,570.4
43	0.0	441.0	1,254.6	9,180.0	10,875.6	125,684.4
44	0.0	441.0	1,254.6	9,180.0	10,875.6	133,225.4
45	0.0	441.0	1,254.6	9,180.0	10,875.6	141,218.7
46	0.0	441.0	1,254.6	9,180.0	10,875.6	149,691.7
47	0.0	441.0	1,254.6	9,180.0	10,875.6	158,673.0
48	0.0	441.0	1,254.6	9,180.0	10,875.6	168,193.4
49	0.0	441.0	1,254.6	9,180.0	10,875.6	178,284.7
50	0.0	441.0	1,254.6	9,180.0	10,875.6	188,981.6
Total	11,197.5	18,031.0	46,420.2	302,940.0	378,638.7	2,914,683.4

Note: The conversion from "real" to "nominal" has been made at the inflation rate of 6%.

Table 5-28 Annual Revenue and Expenditure

(M$1,000)

Year	Inflow	Outflow	Balance	Accum. Debt
1	0.0	8,624.6	-8,624.6	-8,624.6
2	791.3	5,716.2	-4,924.9	-13,549.6
3	838.8	5,603.1	-4,764.3	-18,313.9
4	889.1	5,843.9	-4,954.8	-23,268.7
5	942.4	6,700.8	-5,758.4	-29,027.1
6	999.0	6,782.4	-5,783.4	-34,810.6
7	1,058.9	7,293.7	-6,234.8	-41,045.3
8	1,122.5	6,973.8	-5,851.3	-46,896.6
9	1,892.7	7,909.4	-6,016.7	-52,913.4
10	2,006.2	7,919.3	-5,913.1	-58,826.5
11	2,126.6	9,656.5	-7,529.9	-66,356.4
12	2,254.2	9,939.1	-7,684.9	-74,041.2
13	4,913.9	10,228.7	-5,314.7	-79,355.0
14	5,208.8	10,277.0	-5,068.2	-84,424.2
15	5,521.3	11,119.9	-5,598.6	-90,022.7
16	5,852.6	12,072.1	-6,219.6	-96,242.3
17	27,627.4	10,993.8	16,633.6	-79,608.7
18	29,285.0	9,479.3	19,805.7	-59,803.0
19	31,042.1	18,362.0	20,680.1	-39,122.9
20	32,904.6	10,680.9	22,223.7	-26,899.2
21	34,878.8	30,856.6	4,022.2	-12,877.0
22	36,971.5	16,234.1	20,737.5	7,860.5
23	39,189.8	15,079.5	24,110.2	31,970.7
24	41,541.1	15,526.3	26,014.8	57,985.5
25	44,033.5	17,589.1	26,444.4	84,429.9
26	46,675.5	17,549.9	29,125.6	113,555.6
27	49,476.0	18,892.4	30,583.6	144,139.1
28	52,444.5	16,975.9	35,468.7	179,607.7
29	55,591.1	19,450.7	36,140.4	215,748.2
30	58,926.6	19,074.0	39,852.5	255,600.7
31	62,462.0	24,060.5	38,401.6	294,002.2
32	66,209.7	24,672.8	41,537.0	335,539.2
33	70,182.2	24,492.0	45,690.2	381,229.3
34	74,393.1	24,080.4	50,312.6	431,541.9
35	78,856.6	26,394.6	52,462.0	484,003.9
36	83,587.9	31,352.8	52,235.2	536,239.0
37	88,603.1	35,177.3	53,425.8	589,664.7
38	93,919.2	30,486.4	63,432.8	653,097.6
39	99,554.2	33,231.8	66,322.4	719,419.9
40	105,527.4	34,158.4	71,369.1	790,789.0
41	111,858.9	99,061.2	12,797.7	803,586.7
42	118,570.4	52,063.9	66,506.5	870,093.2
43	125,684.4	48,246.8	77,437.6	947,530.9
44	133,225.4	49,915.4	83,310.1	1,030,840.9
45	141,218.7	56,409.6	84,809.1	1,115,650.0
46	149,691.7	56,147.5	93,544.2	1,209,194.0
47	158,673.0	60,733.7	97,939.3	1,307,133.0
48	168,193.4	54,442.8	113,750.5	1,420,883.0
49	178,284.7	62,217.4	116,067.2	1,536,950.0
50	188,981.6	61,343.8	127,637.7	1,664,587.0

5-7-4 Prospective Income of Settlers and Fluctuations in Labor Demand

The total payment to settlers will amount to M$69.4 million over fifty years, representing the highest single outlay (33.2%). The annual payment to settlers will total M$1,343.6 from the seventeenth year when the project will commence full-scale operation providing a average monthly income of M$279.9 per settler (1,343,600/400 person/12 months). In addition, settlers will be given houses for their use. The monthly outlay for constructing a house worth M$15,000 is M$62.5 (15,000/20 years/12 months). It is assumed that SAFODA should also bear the costs of housing maintenance, power and water supply.

The share of the infrastructure costs to be borne by settlers has not yet been considered, though the benefit principle should be employed. Such a problem will be for SAFODA to resolve in the future. It is anticipated that the wages paid to settlers and the benefits they receive without payment such as roads will raise their standard of living remarkably, even if other farm incomes and prospective employment opportunities are not considered.

The monthly labor demand is summarized in Table 5-29. In the table, it can be seen that demand falls by third between the most busy and least busy working season. In the busiest season, four hundred settlers will be insufficient to meet demand, raising the necessity for employing the family members of settlers. On the other hand, only half of the settlers are employed in the rainy season. This reflects the characteristics of forestry confronting nature.

5-7-5 Facilities and Buildings

Table 5-30 shows the facilities and buildings required in the modified plan.

5-7-6 Vehicle Purchases

The details of vehicle purchases for the project are shown in Tables 5-31 and 5-32.

Table 5-29 Monthly Labor Requirements

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Forest roads												
Supervisors	4	4	4	4	4	4	4	4	4	4	4	4
Workers	20	20	20	20	20	20	20	20	20	20	20	20
Operators	5	5	5	5	5	5	5	5	5	5	5	5
Nursery												
Laborers I $18	10	5	41	41	41	55	15	15	15	7	10	10
Workers II $16 / Casual Workers	24	24	20	20	20	32	58	58	58	45	6	6
Forest plantation												
Workers I $18 / Workers II $16	136	106	150	150	220	370	403	443	214	224	169	131
Drivers	6	6	6	6	6	6	6	6	6	6	6	6
Administration												
Casual Workers $16	3	3	3	3	3	3	3	3	3	3	3	3
Fire prevention $16	3	3	3	3	3	3	3	3	3	3	3	3
Total	211	176	252	252	322	493	517	557	328	317	226	188

Note: The monthly number of laborers is calculated on the basis of 20 working days per month, if labor demand is shown in the annual total.

Table 5-30 Facilities and Buildings

	Construction cost (M$1,000)	Area (m^2)	Unit price of construction (M$/$m^2$)	Depreciation (Years)	Total	
Nursery facilities						
Nursery						
– Irrigation	10.3	1,635	6.3	20	1	
– Other facilities	8.1	3,035	2.6	5	1	
Nursery office	76	80	950	20	1	
Warehouse	65	100	650	20	1	
Garage	35	100	350	20	1	
Resthouse	130	65	200	20	1	
Workshop	105	300	350	20	1	
Soil burning area	5	25	200	20	1	
Burnt soil storage	5	25	200	20	1	
Plantation facilities						
Warehouse	18	300	60	20	1	*1
Plantation office	20	40	500	20	1	
Garage	20	100	200	20	1	
Workshop	15	50	300	20	3	
Management facilities						
Administration office	150	500	300	20	1	*1
Garage	20	100	200	20	1	
Repair shop	20	100	200	20	1	
Shop	30	100	300	20	1	
Warehouse	30	100	300	20	1	
Staff residences (Table 5-19)						
A Class	100	120	833	20	2	
B Class	80	100	800	20	6	
C Class	50	70	714	20	18	*2
D Class & Typist	30	50	600	20	13	
Settlers' residences						
Settlers' residences	15			20	400	
Public facilities (Table 5-18)						
Guesthouse	100			20	1	*3
Chapel/Surau	25			20	2	
School	150			20	1	
Clinic	30			20	1	
Playground						
Public utilities (Table 5-18)						
Power plant	500	(including necessary equipment)				
Water supply	800	(including necessary equipment)				
Sewerage	500	(including necessary equipment)				

*1 Shared buildings
*2 Two for teachers
*3 Including a meeting room

Table 5-31 Vehicles

Type	Purchasing price (M$1,000)	Depreciation (Years)	No.	Operator
Forest road work				
Motor grader (Hp 120)	230	5	1	Operator
Front loader (Hp 80, 1 m³)	150	4	1	"
Dump truck (Hp 100)	75	4	2	"
Bulldozer (Hp 150, 13 ton)	270	5	1	"
Nursery work				
Truck (4 ton)	50	5	1	Nursery Workers & Officers
Wagon 4WD	35	5	1	
Tractor (wheel-type, with trailor)	25	5	1	
Afforestation work				
Truck (4 ton)	50	5	3	Drivers & Officers
Tractor (wheel-type, with trailor)	25	5	3	
Wagon 4WD	35	5	4	
Administration work				
Wagon 4WD	35	5	8	A & B Class Officers
Protection				
Motor bike (125 cc)	3	3	3	Protection Workers

Table 5-32 Vehicle Purchase Schedule

(Unit No.)

Year	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
Forest road																									
Motor grader	(1)					1					1					1					1				
Front loader	(1)				1				1				1				1				1				1
Dump truck	(1)		(1)		1		1		1		1		1		1		1		1		1		1		1
Bulldozer	(1)					1					1					1					1				
Nursery																									
Truck		(1)					1					1					1					1			
Tractor		(1)					1					1					1					1			
Wagon 4WD		(1)					1					1					1					1			
Plantation																									
Truck		(3)					3					3					3					3			
Tractor		(3)					3					3					3					3			
Wagon 4WD		(4)					4					4					4					4			
Administration																									
Wagon 4WD	(2)	(6)				2	6				2	6				2	6				2	6			
Motor bike		(3)			3			3			3			3			3			3			3		

Year	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
Forest road																									
Motor grader	1					1					1					1					1				
Front loader				1				1				1				1				1				1	
Dump truck		1		1		1		1		1		1		1		1		1		1		1		1	
Bulldozer	1					1					1					1					1				
Nursery																									
Truck		1					1					1					1					1			
Tractor		1					1					1					1					1			
Wagon 4WD		1					1					1					1					1			
Plantation																									
Truck		3					3					3					3					3			
Tractor		3					3					3					3					3			
Wagon 4WD		4					4					4					4					4			
Administration																									
Wagon 4WD	2	6				2	6				2	6				2	6				2	6			
Motor bike	3			3			3			3			3			3			3			3			3

( ) indicates new purchase. No parenthesis represents replacement purchase.

5-7-7 Sensitivity Analysis

In the sensitivity analysis, carried out to determine the degree to which the feasibility of the modified plan changes following a given change, it is assumed that revenue and expenditure changed by 5 % and 10 %, respectively. The result is shown in Table 5-33. In both cases, it is judged that the modified plan is feasible.

Table 5-33 Sensitivity Analysis

	Standard	I	II	III	IV	V
Expenditure	–	No ch.	No ch.	+5%	+10%	At times of a surplus, settlers receive 1/3 of profits.
Revenue	–	–5%	–10%	No ch.	No ch.	
Project FIRR	11.5	11.0	10.5	11.1	10.6	9.6
Year in which accum. surplus will be first recorded	22	23	23	23	23	24
Maximum cash deficit (M$ million)	–96.2	–93.0	–93.9	–102.9	–109.5	–95.2
Cumulative cash surplus in the fifties year (M$ million)	1,661.7	1,518.9	1,373.2	1,692.1	1,539.6	1,077.7

In addition to these hypothetical cases, the financial internal rate of return (FIRR) is calculated on the assumption that when the operation is in a surplus, one third of the profits is being distributed to settlers.

5-7-8 Conclusion

As previously mentioned satisfactory results were obtained from the analyses in terms of the feasibility of modified plan, the prospective incomes of the settlers, and the revenue and expenditure of SAFODA. It is proved that the modified plan could be implemented even if given conditions change. Thus, it is concluded that the modified plan is feasible from the financial point of view.

5-8 Economic Analysis

5-8-1 Economic Internal Rate of Return (EIRR)

EIRR is usually calculated on the basis of FIRR through the following adjustment procedures:

- o A shadow price is used for the foreign portion.
- o A shadow price is used for estimating the labor cost.
- o Residual value, consumers' surplus, interest, price increases, taxes and royalties are not calculated.
- o Administration expenditure is excluded from outlays.

The following adjustments have been made for calculation purposes in this study:

- o For vehicles included in the foreign portion, the amount equivalent to the import duty is deducted.
- o The labor cost is calculated on the basis of M$3 per person per day.
- o Administration expenditure is deducted from outlays.
- o Community cost is excluded from both the outlays and benefits. In other words, EIRR is estimated only for afforestation, because community cost is the transfer from the Government to the settlers.
- o As for benefits the revenue incoming from timber sales only is included in calculations.
- o The portion adjusted for inflation is deducted.

The EIRR of 16.1% was thus obtained.

The Bengkoka Project has two objectives: Afforestation and settlement. Settlement is characterized by the employment opportunities the Government gives to farmers engaging in shifting cultivation, in the form of social welfare through wage payments. In economic analysis, the transfer of revenue and payments between economic entities is excluded, thus making it difficult to obtain a reliable numerical assessment.

Although the estimates are limited only for afforestation and the revenue through the sales of timber only has been calculated, the EIRR figure is a relatively high 16.1%. When considering the following benefits that can not be numerically shown, the economic benefits of the project are considerable.

5-8-2 Benefits That Can Not Be Numerically Calculated

(1) Afforestation benefits

o Regenerating forest resources

Forest resources, unlike mineral resources, can be regenerated. Forests are the most important resource in Sabah State. Forest resources in Sabah have, however, been deteriorating in quantity and quality, and therefore, enormous benefits can be expected from the regeneration of forest resources by the re/afforestation.

o Forest and water resources conservation

The depletion of forest resources has meant that the quality of forests is continually deteriorating. Further, shifting cultivation has reduced the quality of the soil. If this plan is implemented, however, shifting cultivation will be stopped, and re/afforestation will exert a remarkable effect on the conservation of forest land and water resources.

o Improvement of land productivity

Although the soil conditions of Division V are better than average in Bengkoka, it is difficult to raise land productivity by means other than the planting of *Acacia mangium*.

o Improvements in technology by large-scale re/afforestation

In Sabah State re/afforestation work has been undertaken in recent years, but large-scale re/afforestation such as that involved in the modified plan has not occurred. The modified plan will remarkably upgrade re/afforestation technology.

(2) The Benefits of settlement

o The settlement of those people who previously were dependent on shifting cultivation will be achieved.

o Improvement in livelihood

As explained in Section 2, the living conditions of people in Division V are among the lowest in Malaysia. If the modified plan is implemented, the basic living infrastructure, such as water and power supply will be improved. Educational, medical and other facilities which previously scarcely existed will be provided.

o The creation of employment opportunities

Re/afforestation, other operations and related-industries will create employment opportunities which previously did not exist.

5-8-3 Conclusion

What is crucial in this regard is the location of Bengkoka. Generally speaking, in most cases of economic development planning, improved industrial development is the main objective. Considering the location of Bengkoka, the improvement of forest resources by re/afforestation is surely the most appropriate operational activity. There is of course a possibility of developing timber-related industries in the future, but as the initial measure, the development outlined in the modified plan is urgently required.

What is required in Sabah State is not only to protect the present existing forest resources but to develop the future resource potential of this area. In this sense the project is meaningful in that it sheds light upon the future of Sabah, and at the same time has the objective of improving the basic living conditions of the local residents.

It may be judged that this Bengkoka Afforestation and Settlement Project is amply meaningful from the national point of view.