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Preface

Our agency has commenced the Technical Cooperation for the Trial Plantation Project in the South Sumatra in order to establish the afforestation technique for grassland in the Republic of Indonesia. For this purpose, the Implementation design survey team headed by Mr. Ryosuke Kato, Chief of Overseas Cooperation & Information Section, Forestry and Forest products Research Institute, was sent to Indonesia in September, 1979.

The trial plantation design necessary for the improvement and development of the afforestation technique examined as well as the forest roads, nurseries and other facilities essential for the trial plantation were designed during the survey.

This report is a compilation of the data obtained from the aforementioned survey and I am sure it will be an important guideline for the future development of this project.

I would like to take this opportunity to express my most sincere gratitude to the officials of the Indonesian and Japanese authorities as well as to those who participated in this survey for their immense cooperation.

Kenji Hori

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Director,
Forestry Development Cooperation
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§ 1. Objective & Outline of the Survey

1-1 Development & Objective

1-1-1 Development

- (1) Mr. Sudjarwo, Director of General Directorate of Forestry, the Republic of Indonesia requested the cooperation of the Japanese Government on afforestation in Indonesia during his visit to Japan in 1972.
- (2) Japanese cooperation for the afforestation of the grasslands in Kalimantan, Sumatra, etc. was requested by the Directors of Planning, of Reforestation & Land Rehabilitation, and of the Forest Research Institute during their visits to Japan in 1974.
- (3) The Japan International Cooperation Agency performed the initial basic development survey to commence the afforestation project as a development and cooperation project in June 1975. Hereupon, local surveys were performed in North and South Sumatra, then the grasslands and forests of South Sumatra were selected as the most suitable area for this afforestation project.
- (4) Cooperation between Indonesia and Japan for afforestation as well as other fields of forestry were discussed by the Director General of Forestry and other accompanying senior officers during their visits to the Forestry Agency of Japan and the Japan International Cooperation Agency in November 1975.
- (5) In November 1975, the Japan International Cooperation Agency performed the second basic development survey for the afforestation project as a development and cooperation project. Additionally, negotiations were held with the Indonesian Government on the planning for the afforestation project in the grasslands of the Benakat and Subanjeriji areas in South Sumatra. Hereupon, the basic program was compiled based on the detailed information and data obtained from these surveys as well as through local surveys.

- (6) Based on the results of the second basic development survey, a survey team was sent to discuss the planning for this survey in August 1976. Then, agreement to establish the cooperation project on a Government to Government basis was made upon negotiations with the Indonesian Government.
- (7) This Afforestation Development Cooperation Project was listed on the BAPPENAS list, and was officially requested of the government of Japan in April 1977.
- (8) The Scope of Work for this project was concluded in September 1977.
- (9) Based on the this S/W, aerial photography covering 50,000 ha in the Benakat area was commenced to shoot in November 1977.
- (10) The topographical charts were commenced to make in May 1978.
- (11) Soil survey and afforestation planning etc. were performed in accordance with the Afforestation Development Cooperation Project in June 1978.
- (12) The R/D for the technical cooperation of this project was concluded in April 1979.

1-1-2 Objective of the Survey

The objective of this project along with the conclusion of the R/D is to produce an experimental plantation of 2,100 ha in the Benakat area as an inter-government cooperation project, and to analyze the problems of planting and mechanization in grasslands. Therefore, this survey is performed to discuss an executive system on actual works by the both Governments as well as to discuss the principal items concretely which are concerned with the nursery construction and the experimental plantation in order to enhance this technical cooperation project. In other words, the main objectives are to decide the location of the nursery, the actual layout for the various facilities, and to make working schedules with its methods.

Other objectives are to establish the annual plan of experimental plantations in each section and to do the execution plan in its individual work for afforestation, as well as the survey and design for the construction of the main forest roads and of the working ones. In addition, it is required to perform a survey necessary for the planning for a lookout tower and fire protection belts.

1-2 List of Survey Participants and Survey Schedule

1-2-1 List of Survey Participants

(1) Composition of the Forestry Execution Design Survey Team

Name	Specialty	Present Job
Ryosuke Kato	Survey Team Leader (General Manager)	Forestry Research Institute
Katsuyuki Ohmi	Afforestation Design	Forestry Agency
Hirota Yamate	Nursery Site Design	Forestry Agency
Tsuyoshi Takashima	Forest Road Design	Technical Staff Japan Overseas Forestry Consultants Association
Tadao Ohara	Afforestation Design	Technical Staff Japan Overseas Forestry Consultants Association
Eiji Nitsu	Nursery Design	Technical Staff Japan Overseas Forestry Consultants Association
Yoshifumi Azumi	Forest Road Design	"
Tomochika Uchida	Coordination	Japan International Cooperation Agency

(2) Indonesian Participants

Name	Present job
Haris Surrange Ojiwa	Director of Bina program
Soeharto Soemarmo	Directorate of Reforestration & Land Rehabilitation
Harsone Rekso Wardoyo	"
Arip PS Sagsla	"
Zulkifli Mulsani	"
Wazil Nengkeman	South Sumatra Regional Forest Office

1-2-2 Survey Schedule

This survey was performed over a 34 day period from 11 September to 14 October 1979. The survey schedule was as described in the following:

Day number	Month	Day	Day of the week	Progress	Survey Details
1	9	11	Tuesday	Tokyo (Narita) to Jakarta	
2		12	Wednesday		Courtesy call to the Japanese Embassy and JICA Jakarta Office.
3		13	Thursday		Courtesy call and discussion with the Directorate of Reforestation & Land Rehabilitation.
4		14	Friday	Jakarta to Bogor	Courtesy Call to the Directorate of Planning.
5		15	Saturday	Jakarta to Palembang	Moved to Palembang. Courtesy Call and discussion with the Regional Forest Office.
6		16	Sunday		Data Collection and survey preparation

Day Number	Month	Day	Day of the week	Progress	Survey Details
7	9	17	Monday	Palembang to Peudopo	Moved to Pendopo Surveyed the experimental plantation
8		18	Tuesday		Benakat Area general site Survey
9		19	Wednesday		General investigation on the experimental plantation
10		20	Thursday		Survey and investigation on the planned nursery site
11		21	Friday		Same as the above
12		22	Saturday		Clear cutting and selected point survey of the planned forest road line
13		23	Sunday		Same as the above
14		24	Monday		Natural forest soil survey and planned nursery site survey
15		25	Tuesday		Forest road survey
16		26	Wednesday		Forest road survey
17		27	Thursday		Forest road survey
18		28	Friday		Forest road survey
19		29	Saturday		Forest road survey
20		30	Sunday		Determination of the plantation area border
21	10	1	Monday		Determination of the plantation area border and survey of the working forest road
22		2	Tuesday		Same as above
23		3	Wednesday		Survey of the nursery
24		4	Thursday		Survey on the existing nursery and plantation area
25		5	Friday		Data collection at P.T. Swoody Ltd.
26		6	Saturday	Pendopo to Palembang	Moved to Palembang

Dat number	Month	Day	Day of the week	Progress	Survey Details
27	10	7	Sunday		Data storing
28		8	Monday		Reported to the Regional Forest Office and data collection
29		9	Tuesday	Palembang to Jakarta	Moved to Jakarta/ Survey results consolidation
30		10	Wednesday		Reported to the Japanese Embassy and JICA
31		11	Thursday		Compiling of the report Discussion of the apportionment, etc. Preparation of maps Data consolidation
32		12	Friday	Jakarta to Bogor	Reported to and discussion with the Directorat General of Forestry
33		13	Saturday	Jakarta to Tokyo (Narita)	Parting Call to the Japanese Embassy and JICA
34		14	Sunday		

1-2-3 Summary of the Survey

There are approximately 16,000,000 ha of grasslands in Indonesia on which afforestation projects are currently being performed. The planted area for fiscal years 1972/1973 to 1976/1977 are described below.

1972/1973	82,700 ha
1973/1974	78,800 ha
1974/1975	84,300 ha
1975/1976	25,300 ha
1976/1977	162,800 ha

However, planting results aside from Java in the outer territories are poor due to the poor soil conditions and the poor treatment for planted trees because of its sparse population. As a result, the survival rate in the Benaket area, for example, is only 20 to 30 %.

With these facts taken in consideration, the afforestation project is only successful by the proper selection of appropriate tree species to

establish adequate afforestation technology and the establishment of a mechanized afforestation system to compensate for the sparse population.

Initially, the various problems of afforestation must be solved. This is why technical cooperation for the experimental plantation is necessary.

This technical cooperation project is scheduled for the 5 years between 1979/1980 and 1983/1984 with the following works in the Benakat area.

- (i) Experimental Plantation
- (ii) Nursery Operation
- (iii) Planting Operation
- (iv) Study of Countermeasures for Forest Fires, Pests, Insects, and Weather
- (v) Study of the Design, Execution, and Maintenance of Forest Roads as well as road surface and slope protection.
- (vi) Study for the introduction of Mechanization
- (vii) Effect of the plantation on the natural environment
- (viii) Effect of the plantation on the social environment
- (ix) Design and Technical Details for the Actual Plantation
- (x) Other necessary technologies

Experimental plantation is scheduled to be performed within the 2,100 ha area in the national forest in Benakat. The annual planting schedule within the 5 year cooperation period is scheduled as follows:

- (1) Initial Year: Construction of the nursery and preparation of the planting area.
- (2) Second Year : 200 ha
- (3) Third Year : 400 ha
- (4) Fourth Year : 700 ha
- (5) Fifth Year : 800 ha

However, approximately 60% of the experimental plantation area was covered by the plantation with *Peronema canescens* in 1976/1977 and the

remaining 40% was done by the plantation with *Pinus Merkusii* in 1977/1978. As for the aforementioned *Peronema canescens* plantation, the survey for the survival rate made in 1979 exhibited 5~40%, 20% on the average, and therefore requires urgent replanting. This planted area is to be used for the project site. On the other hand, the *Pinus merkusii* plantation area is to be incorporated within the experimental plantation area, but the final determination is to be made after the survival rate survey scheduled in 1980.

In the experimental plantation area there grow some shrubby species such as *Melastone*, *Eupatium*, *Lantana* and so on mixing with *Alan-Alan*, then its vegetation is quite different from the vegetation, *Alang-Alang* grassland, so-called. Therefore, bush cutters and chain saws must be used for weeding since much time and many labores are expected to be required for the weeding in the plantation compared to *Alang-Alang* grasslands.

The planned nursery will be permanent, and therefore, facilities such as a project office, machinery repair shop, warehouse, meeting hall, nursery facility, dormitory for experts, guest house, and other associated facilities are to be constructed.

The nursery is to be located in the vicinity of the former nursery site on the BAUNG river.

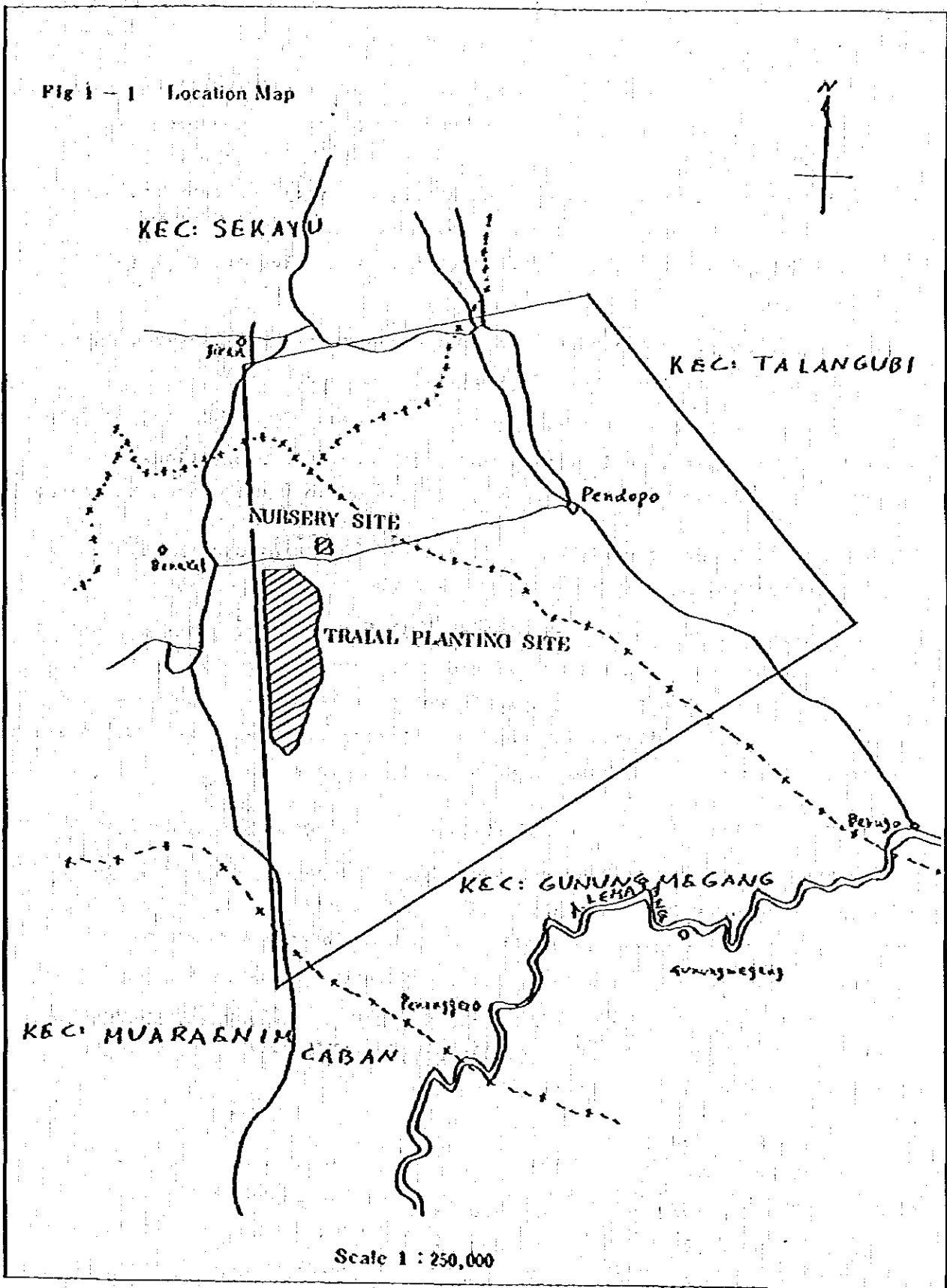
The experimental planting is to be done with 8 tree species consisting of fast growing species, pine, and general broad leaved tree species as determined most appropriate for the afforestation technology and mechanization of the appropriate species.

Additionally, planting possibility and adaptability are to be tested for 20 to 25 Indonesian and foreign species when their seeds will be obtained.

The road is to be designed with a main forest road running in the North-South direction along the boundary of the watershed in the experimental plantation area, a working forest road circulating along the perimeter of the experimental plantation area, and feeder roads connecting the main and the working forest road. The overall road construction plan comprises approximately 9.4 km of main forest roads, 33 km of working forest roads, and 31 km of feeder roads, with its total length of 73.4 km and 35.0 m per ha. The width of the road is to be 10 m for the main forest road and 8 m for the working forest road and feeder roads. Slope protection is to be accomplished by planting local sod in order to prevent erosion.

60 cm diameter corrugated pipes are to be used for closed conducts due to their ease of construction and are to be used in double or triple rows in such areas where large amount of water is running.

Fig 1 - 1 Location Map



Design of Experimental Plantations

2-1 Design Principles

The basic principles for experimental plantations are (i) the selection of suitable tree species and establishment of planting technology in grassland of tropical rain forest, (ii) establishment of efficient and effective planting systems by mechanization, and (iii) suitability and adaptability tests of domestic and foreign tree species.

The details of the three aforementioned principles are explained in the following:

- (i) Selection of suitable tree species and establishment of planting technology in grassland of tropical rain forests (A) *Growth Increment Test*

Adaptability tests of tree species presently planted in tropical rain forests in Indonesia, Philippines, and Fiji, etc. for plantations in grasslands including the experimental plantation in Benakat area of Indonesia.

- (ii) Establishment of efficient and effective planting systems by mechanization test (B) *ISO*

For mechanization in each work of soil preparation, planting, and nursing, these tests consist of different two stages. The first is a trial use of machines and equipments which exist now. Then the second is to improve them suitable for the character of tropical soil and topography in order to establish mechanized planting technology.

- (iii) Forest test of domestic and foreign tree species Survival (C) *Introduction Test*

This test is to find possible domestic Indonesian trees for this plantation such as Meranti, Balau, Ulin, and Kemiri as well as to determine the adaptability of trees presently planted in foreign nations to Indonesia. These tests are to be performed in the Bunakatt area 2,100 ha over 4 years from the second year after the commencement of the cooperation program (1980/1981 A.D.) thru the fifth year (1983/1984). The annual plantation are as listed below.

1980 / 1981	200 ha
1981 / 1982	400 ha
1982 / 1983	700 ha
1983 / 1984	800 ha
Total	2,100 ha

The following are the tree species object for the experimental plantation.

Growth Increment Test (A) -- 8 species

(a) Fast Growing Tree Species

Albizzia falcata, *Eucalyptus deglupta*, *Anthocephalus cadamba*,
Acacia auriculaeformis *Schima bancana*.

(b) Pines

Pinus merkusii,

(c) General Lumber Tree Species

Swietenia macrophylla,
Peronema canescens.

Mechanization Test (B) -- 8 species

(a) Fast Growing Tree Species

Albizzia falcata, *Eucalyptus deglupta*, *Anthocephalus cadamba*,
Acacia auriculaeformis, *Schima bancana*.

(b) Pines

Pinus merkusii.

(c) General Lumber Tree Species

Swietenia macrophylla.
Peronema canescens.

Introduction Test (C) -- 25 species

(a) Domestic Indonesian Species

Aleurites moluccane, *Eusideroxylon zwageri*, *Shorea* sp.
Hopea sp., *Octomelis sumatrana*, others.

(b) Foreign Species

Comnosperea auriculata, *Dalbergia latifolia*, *Cordia alliodora*,
Albizzia lebbeck, *Cedrea odorata*, *Cedrea toona*, *Peterocarpus indicus*,
Acacia nancun, *Legume* sp., *Giant ipil ipil*, *Ochroma bicolor*, *Pinus*
Caribaea var *hondurensis*, *Khya* sp. *Enterolobium* sp, *Pterigota allata*,
Gaelina arborea, others.

2-2 Test Items and its Objectives

The items and objectives of these tests are as described in the following:

(i) Local Topography

This is a growth increment test performed in accordance with the land description with the objective for the determination of the most suitable tree species for the terrain.

The difference of the soil type in the experimental plantation area was determined to be in accordance with the local topography by the soil survey performed for the "Soil Survey & Afforestation Plan for The Afforestation Cooperation Project in Benakat area, South Sumatra, Indonesia".

Furthermore, upon analyzing the factors of the suitable plantation area determination, it was found that the partial correlation coefficient on the productivity of the forest was 0.3323 on local topography, 0.2867 on soil, and correlation coefficient was 0.447 on local topography, 0.405 on soil.

Therefore, the local topography greatly effects the productivity of the forest. This is why the local topography including the soil is employed for this test.

(ii) Preparation of Soil for Planting

Although 1 meter wide stripe weeding is presently applied, the results are not favorable due to the suppression by the remaining Alang-Alang or other shrubs as well as the temperature elevation caused by the lack of ventilation. Effects with and without the residual shrubs (including Alang-Alang) to the planted trees as well as to the weeding after preparation of soil for planting are studied in this test.

(iii) Planting Density

The planting density is determined in accordance with the different characteristic of each tree species and the use of the yield.

But there are some species which are used for both pulp and lumber among those 8 species employed for this test. Additionally, effects of weeding, cleaning cutting, and thinning are tested as supplements to establish the nursing technique.

(iv) Mixed Planting of Soil Improving Trees

This test is performed to see the effects on growing of trees. Because it is generally expected that physical, chemical, and microbiological conditions of the stand must be improved better for the growth of planted tree species by this mixed planting.

(v) Planting Time

The present planting time is in those three months from the beginning to the middle of the rainy season between November and January. Large amount of manpower are required to accomplish project-scale plantation (several thousand ha) when the planting time is restricted to these three months. Tests are performed to verify the thru-year applicabilities of the various work as well as to average the labor load.

(vi) Planting Method

Species except *Peronoma canescens* which is planted by direct slip are planted with the seedlings presently. Additionally, although the plant hole dimensions are to be 50 x 50 cm with a depth of 30 cm, planting are actually performed with hoes. The planting holes are to be promptly plowed to the aforementioned dimensions in this test to verify the effect of the tillage. Furthermore, the effects are to be verified not only for the seedlings but for the direct sowing and direct slip planting methods also in order to reduce the nursery cost.

(vii) Fertilization

The Soil fertility of the overall experimental area is reduced considerably due to the burning over extended periods of time as well as by the repetition of shifting and grazing. Therefore, the effect of fertilization for the improvement of the initial plant growth as well as for the preservation and improvement of the soil fertility by the early stage crown cover, etc. are verified in this test., .

2-3 Layout of the Experimental Plantation Section

The experimental plantation area was established in the national forest approximately 12km west of Pendopo. The experimental plantation is approximately 2,450 ha and are sectioned as described in the following:

Experimental Plantation Section	2,100.0 ha
Facilities Area	3.0 ha
Forest Road & Fire Protection Belt Area	210.0 ha
Left - over Area	132.0 ha
Total	2,445.0 ha

The following three experimental blocks are layed out in the experimental plantation area. (Diagram refers)

1) Growth Increment Test Plantation Section A	1,000 ha
2) Mechanization Test Plantation Section B	850 ha
3) Three Species Introduction Test Plantation C	250 ha
Total	2,100 ha

Following to these, the individual experimental plantation blocks are further sectioned into 50 ha sections (forest compartments). (Diagram refers)

Fig 2-1 EXPERIMENTAL BLOCK SITUATION MAP

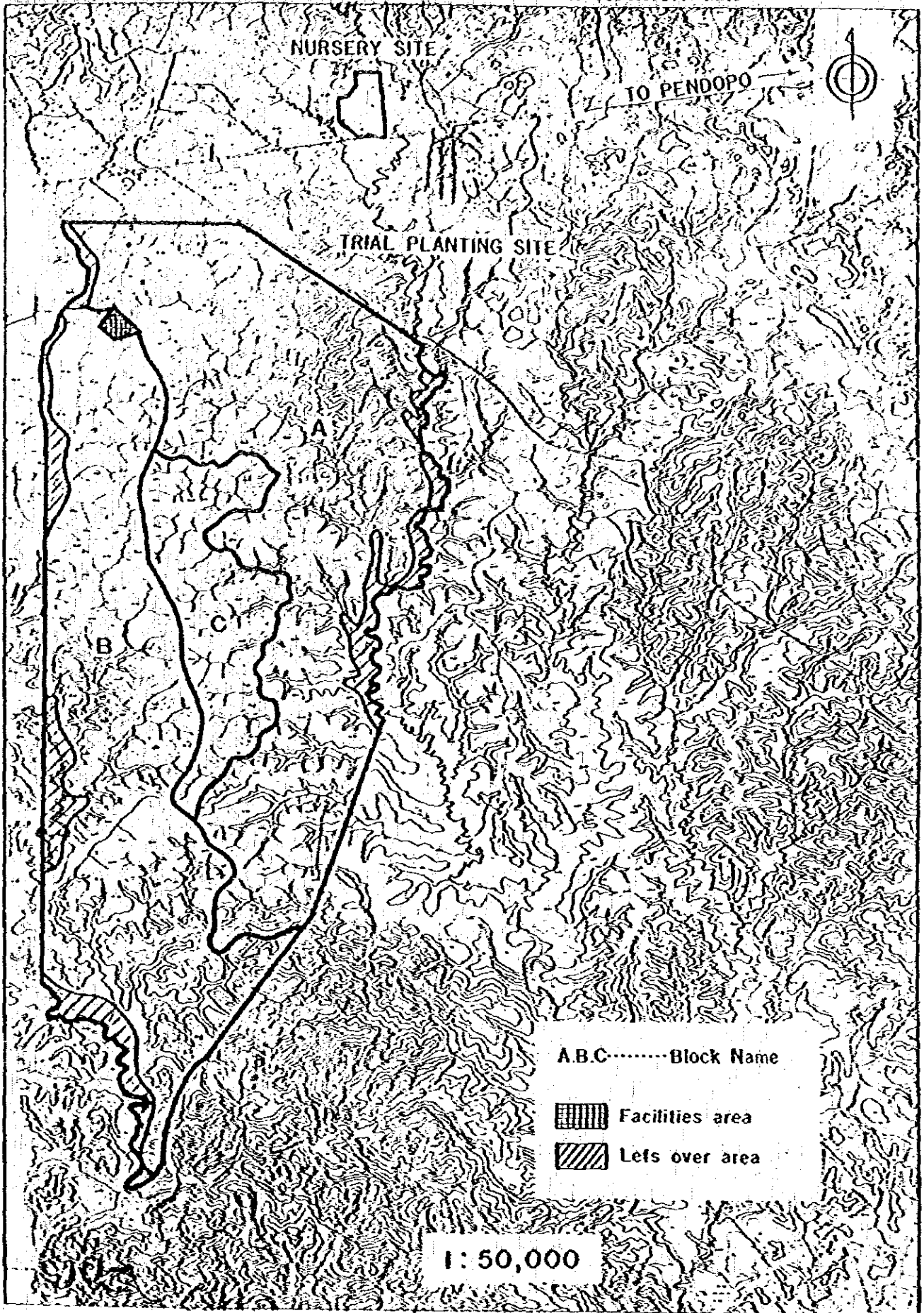
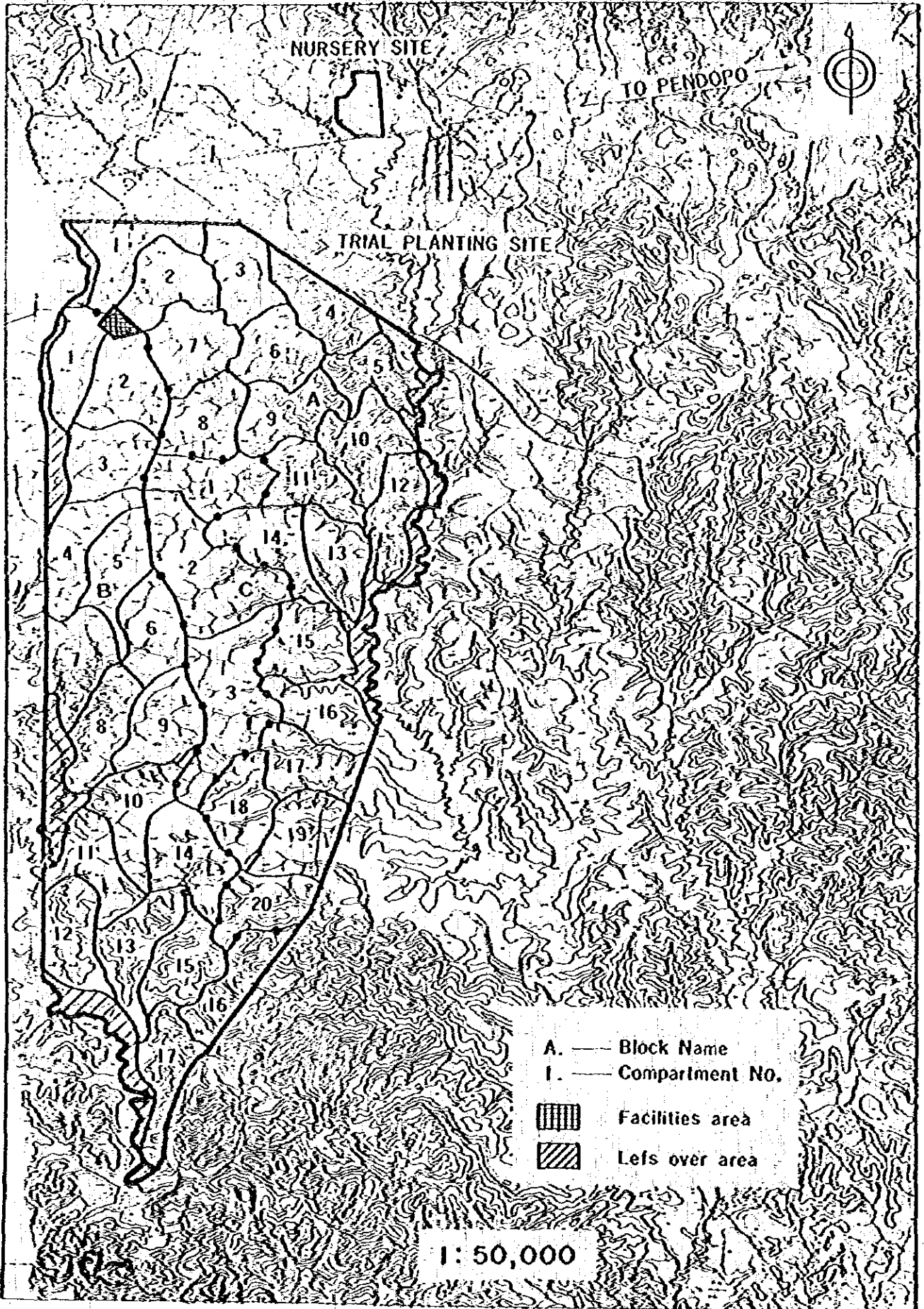


Fig 2 - 2 FOREST COMPARTMENT MAP



The annual planting area according to the individual forest sections are as listed in the following:

	A block	B block	C block	Total
1980/1981	200 ha			200 ha
1981/1982	200	150 ha	50 ha	400
1982/1983	300	300	100	700
1983/1984	300	400	100	800
	1,000	850	250	2,100

The growth increment test (A) is performed for the eight subject species. And it is done with 50 ha for each species, once or three repeated times.

$$\begin{array}{l}
 6 \text{ species} \times 50 \text{ ha} \times 3 \text{ times} = 900 \text{ ha} \\
 2 \text{ species} \times 50 \text{ ha} \times 1 \text{ time} = 100 \text{ ha} \\
 \left. \begin{array}{l} \\ \\ \end{array} \right\} \text{Total } 1,000 \text{ ha}
 \end{array}$$

The mechanization test (B) is performed for the eight subject species once to three repeated times with 50 ha for a single species.

$$\begin{array}{l}
 3 \text{ species} \times 50 \text{ ha} \times 3 \text{ times} = 450 \text{ ha} \\
 3 \text{ species} \times 50 \text{ ha} \times 2 \text{ times} = 300 \text{ ha} \\
 2 \text{ species} \times 50 \text{ ha} \times 1 \text{ times} = 100 \text{ ha} \\
 \left. \begin{array}{l} \\ \\ \end{array} \right\} \text{Total } 850 \text{ ha}
 \end{array}$$

The tree species introduction test is performed for the 25 subject species with 10 ha for each species, totalling 250 ha.

The planting area in accordance with the year, species, and experimental plantation section are consolidated into the Table 2-1.

Table 2-1 Annual Planting Area for Each Tree Species

Classification	Tree Species	Year				Total
		1980/1981	1981/1982	1982/1983	1983/1984	
A	<i>P. merkusii</i>	50 ha	ha	50 ha	50 ha	150 ha
	<i>A. falcata</i>	50		50	50	150
	<i>S. macrophylla</i>	50		50	50	150
	<i>E. deglupta</i>	50		50	50	150
	<i>A. auriculaeformis</i>		50			50
	<i>S. bancana</i>		50	50	50	150
	<i>P. canescens</i>		50			50
	<i>A. cadamba</i>		50	50	50	150
		(200)	(200)	(300)	(300)	(1,000)
B	<i>P. merkusii</i>		50	50	50	150
	<i>A. falcata</i>		50	50	50	150
	<i>S. macrophylla</i>			50	50	100
	<i>E. deglupta</i>		50	50	50	150
	<i>A. auriculaeformis</i>			50	50	100
	<i>S. bancana</i>			50	50	100
	<i>P. canescens</i>				50	50
	<i>A. cadamba</i>				50	50
		(150)	(300)	(400)	(850)	
C	5 Species		50			50
	10 Species			100		100
	10 Species				100	100
			(50)	(100)	(100)	(250)
Total		200	400	700	800	2,100

2-4 Experimental Plantation Execution Plan

2-4-1 Experiment Sections

Establishment of the conditions for each test item aforementioned in the (1) Design of Experimental Plantations are to be as described in the following to establish test sections according to the tree species within the forest compartment with combinations of the individual conditions.

(i) Local Topography

The topographical conditions within the experimental plantation are may be largely segregated into the top, middle, and bottom planes of the upland. The topographical conditions for the tests are segregated into the top plane of the upland including the middle plane (called the top of the upland) and the middle plane of the upland including bottom plane (called the bottom of the upland). The top of the upland is a relatively low producibility area while the bottom is a relatively high producibility area.

(ii) Preparation of Soil for Planting

The preparation for planting is accomplished by stripe weeding, overall weeding, and overall burning. These are performed with equipments such as chain saws and bush cutters, etc. The stripe weeding width is to be one meter. Burning is to be accomplished in heaps after finishing the overall weeding.

(iii) Planting Density

The planting density is to be in accordance with the following, three variations:

(Tree crops per ha)

2500 trees	2m x 2m
1250 trees	4m x 2m
625 trees	4m x 4m

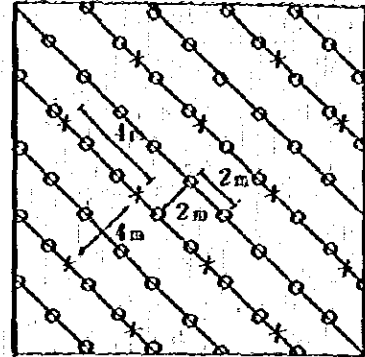
(iv) Mixed Planting of Soil Improving Trees

Leucaena glauca is employed as a soil improving tree and this is planted in 1/2 of the experiment section. The planting density of soil improving trees is to be always 625 trees per ha (4 x 4m).

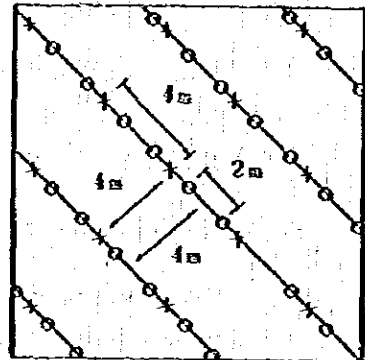
The mix planting of main trees and soil improving trees are to be as illustrated in the diagram below.

However, soil improving trees are not to be planted with Giant Ipil-Ipil.

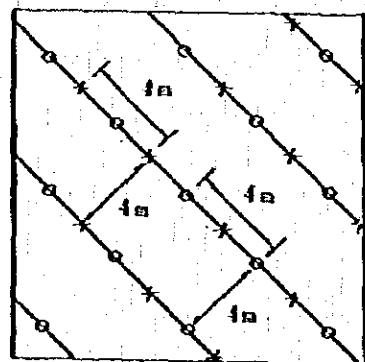
2,500 Trees Per Ha
(2 m x 2 m)



1,250 Trees Per Ha
(4 m x 2 m)



625 Trees Per Ha
(4 m x 4 m)



- O Experimental Plantation Tree Species
- X Soil Improving Trees
- Planting Row

(v) Planting Time

The planting is to be accomplished in the following three periods of the rainy season (November thru January), intermediate season (March thru May), and the dry season (July thru September).

(vi) Planting Method

The planting is to be accomplished by spot planting with dimensions of 50 x 50cm and a depth of 30cm. Additionally, the seedlings employed are to be nursery stocks.

P.merkussi, *A.falcata*, *A. auriculaeformis*, -----Ordinary seeding
A.cadaba

S.macrophylla, *S.bancana*, -----Stump seeding

P.canescens, -----Cultivated cuttings

* Experimental planting

S.macrophylla, *L.glauca*, -----Direct seeding

P.canescens, -----Direct scion slip
planting

2-4-1-1 Plantation Growth Increment Test

Test sections for the conditions described in the following are established for the eight aforementioned subject species to perform the test once to three times at 50 ha for each species to total 1,000 ha.

(i) Topography

Top & bottom of the upland.

(ii) Preparation of Soil for Planting

Basically stripe weeding with tests performed separately for overall weeding and burning.

(iii) Planting Number

2,500, 1,250, and 625 tree crops per ha.

(iv) Mixed Planting of Soil Improving Trees

Existence of mix planting.

(v) Planting Time

Basically to be between November thru January ; but tests are performed separately for March thru May and July thru September.

(vi) Planting Method

The planting is to be accomplished by spot planting with dimensions of 50 x 50cm with a depth of 30cm using nursery stocks.

Furthermore, direct sowing and slitting are also performed on some tree species.

The number of test sections in accordance with the combination of six items per species are as described below:

(Topography) (Preparation of Soil for Planting) (Planting Density) (Mixed Planting of Soil Improving Trees) (Planting Time) (Planting Method)

2 x 1 x 3 x 2 x 1 x 1

= 12

It becomes as listed in the following when consolidating for 50 ha per species. However, the conditions preclude those with a single test section.

Planting Density	Topography	Soil Improving Tree	Area	Total	Grand Total
2,500 (2m x 2m)	Top of the Upland	Mixed	4.0 ha	ha	ha
		None	4.0		
	Bottom of the Upland	Mixed	4.0	16.0	
		None	4.0		
1,250 (4m x 2m)	Top of the Upland	Mixed	4.0	16.0	50.0
		None	4.0		
	Bottom of the Upland	Mixed	4.0	16.0	
		None	4.0		
625 (4m x 4m)	Top of the Upland	Mixed	4.0	16.0	
		None	4.0		
	Bottom of the Upland	Mixed	4.0	16.0	
		None	4.0		
Preparation of Soil for Planting (Overall Weeding, Burning), Planting Time (March thru May) (July thru September) Planting Method Tests are Performed (Direct Sowing) (Direct Slip Planting)				2.0	

2-4-1-2 Mechanization Test

Test sections with conditions described in the following are established for the eight aforementioned species to verify the introduction of mechanization once to three at 50 ha for each species to total 800 ha.

- (i) Topography
Top and bottom of the upland.
- (ii) Preparation of Soil for Planting
Basically to be stripe weeding and stripe plowing with tests performed separately for overall weeding and plowing.
- (iii) Planting Density
1,250 or 625 tree crops per ha.
- (iv) Mixed Planting of Soil Improving Trees.
Existence of mix planting.
- (v) Planting Time
November thru January
- (vi) Planting Method
Nursery stocks are to be employed.

The number of test sections in accordance with the combination of the six items per species are as described below;

(Topography)	(Preparation of Soil for Planting)	(Planting Density)	(Mixed Planting of Soil Improving Trees)	(Planting Time)	(Planting Method)						
2	x	1	x	2	x	2	x	1	x	1	= 8

It becomes as listed in the following when consolidated for 50 ha per species. However, the conditions preclude those with a single test section. (Page 28 List).

Planting Density	Topography	Soil Improving Tree	Area	Total	Grand Total
1,250 (4m x 2m)	Top of the Upland	Mixed	6.0 ha	24.0	50.0
		None	6.0		
	Bottom of the Upland	Mixed	6.0		
		None	6.0		
625 (4m x 4m)	Top of the Upland	Mixed	6.0	24.0	
		None	6.0		
	Bottom of the Upland	Mixed	6.0		
		None	6.0		
Tests are performed for overall weeding and plowing. The planting density is to be 1,250 tree crops per ha.				2.0	

Mechanization introduction tests are to be performed in the individual test sections established by the aforementioned for the individual works such as preparation of soil for planting, plowing, planting, fertilizing, and weeding.

2-4-1-3 Tree Species Introduction Tests

Introduction tests to verify the adaptabilities and possibilities of plantation are to be performed to the 21 domestic Indonesian and foreign species added with species currently being tested for plantation in other tropical rain forest zone nations to total about 25 species.

Tests sections for the conditions described below are established with 10 ha per species to total 250 ha.

(i) Topography

Top and bottom of the upland.

(ii) Preparation of Soil for Planting

Stripe Weeding

(iii) Planting Density

2,500 and 625 tree crops per ha.

(iv) Mixed Planting of Soil Improving Trees

Mixed or none.

(v) Planting Time

Same as B.

(vi) Planting Method

Same as A.

The number of test sections in accordance with the combination of the six items per species are as described below:

(Topography) (Preparation of Soil for Planting) (Planting Density) (Mixed Planting of Soil Improving Trees) (Planting Time) (Planting Method)

2 x 1 x 2 x 2 x 1 x 1 = 8

It becomes as listed in the following upon consolidating for 10 ha per species. However, those with a single test section are precluded.

Planting Density	Topography	Soil Improving Tree	Area	Total	Grand Total
2,500/ha (2m x 2m)	Top of the Upland	Mixed	1.0 ha	4.0	10.0
		None	1.0		
	Bottom of the Upland	Mixed	1.0		
		None	1.0		
625 /ha (4m x 4m)	Top of the Upland	Mixed	1.0	4.0	
		None	1.0		
	Bottom of the Upland	Mixed	1.0		
		None	1.0		
Planting Time (March thru May) (July thru September) Planting Method (Tests are performed for direct sowing and split planting. The planting density is to be 2,500 tree crops per ha.				2.0	

Mixed planting of soil improving trees is not to be performed for the Giant Ipil-Ipil.

Table 2-2 lists the consolidation of the items and growth increment test (A) and the mechanization test (B) as well as the items and conditions of the tree species introduction test (C) from the aforementioned three experimental plantation sections.

Table 2-2. Table of Experimental Plantations

Kind of Test	Item	Topography		Preparation of Soil for Planting		Planting Density			Soil Improving Tree		Planting Time			Planting Method			area		
		Top of the upland	Bottom of the upland	Stripe weeding	Overall weeding	4	4	4	Mixed	None	Nov. ~ Jan.	Mar. ~ May	July ~ Sept.	Ordinary seeding	Stump seeding	Cultivated cutting		Direct sowing	Direct sifting
						X	X	X											
Growth Test A	<i>P. merkusii</i>	○	○	○	△	○	○	○	○	○	○	○	○	○	○	○	○	○	1500
	<i>A. falcata</i>	○	○	○	△	○	○	○	○	○	○	○	○	○	○	○	○	○	150
	<i>S. macrophylla</i>	○	○	○	△	○	○	○	○	○	○	○	○	○	○	○	○	○	150
	<i>E. deglupta</i>	○	○	○	△	○	○	○	○	○	○	○	○	○	○	○	○	○	150
	<i>A. auriculaeformis</i>	○	○	○	△	○	○	○	○	○	○	○	○	○	○	○	○	○	50
	<i>S. bancara</i>	○	○	○	△	○	○	○	○	○	○	○	○	○	○	○	○	○	150
	<i>P. canescens</i>	○	○	○	△	○	○	○	○	○	○	○	○	○	○	○	○	○	50
	<i>A. cadamba</i>	○	○	○	△	○	○	○	○	○	○	○	○	○	○	○	○	○	150
																		(1,000)	
Tree Species Introduction Test C	<i>G. arborea</i>	○	○	○	-	○	-	○	○	○	○	○	○	○	○	○	○	○	10
	<i>G. ipil ipil</i>	○	○	○	-	○	-	○	○	○	○	○	○	○	○	○	○	○	10
	other species 23 kinds	○	○	○	-	○	-	○	○	○	○	○	○	○	○	○	○	○	230
																		(250)	

△..... Test are also performed

Kind of Test	Item	Topography		Preparation of Soil for Planting		Planting Density			Soil Improving Tree		Planting Time			Planting Method			area		
		Top of the upland	Bottom of the upland	Stripe weeding	Overall weeding	4	4	4	Mixed	None	Nov. ~ Jan.	Ordinary seeding	Stump seeding	Cultivated cutting	Direct sowing	Direct sifting			
						X	X	X											
Mechanization Test B	<i>P. merkusii</i>	○	○	○	△	○	○	○	○	○	○	○	○	○	○	○	○	○	1500
	<i>A. falcata</i>	○	○	○	△	○	○	○	○	○	○	○	○	○	○	○	○	○	150
	<i>S. macrophylla</i>	○	○	○	△	○	○	○	○	○	○	○	○	○	○	○	○	○	100
	<i>E. deglupta</i>	○	○	○	△	○	○	○	○	○	○	○	○	○	○	○	○	○	150
	<i>A. auriculaeformis</i>	○	○	○	△	○	○	○	○	○	○	○	○	○	○	○	○	○	50
	<i>S. bancara</i>	○	○	○	△	○	○	○	○	○	○	○	○	○	○	○	○	○	100
	<i>P. canescens</i>	○	○	○	△	○	○	○	○	○	○	○	○	○	○	○	○	○	100
	<i>A. cadamba</i>	○	○	○	△	○	○	○	○	○	○	○	○	○	○	○	○	○	50
																		(850)	

2-4-2 Work Methods with Mechanical Equipments

The following mechanical equipments are to be employed for the various works in the three aforementioned experimental plantation sections.

(I) Growth Increment Test (A) & Species Introduction Test (C)

Preparation of Soil for Planting - Chain Saw, Bush Cutter

Planting Hole Digging - Auger

Planting - Holer

Fertilizing - Holer

Bush Cutting - Bush Cutter

Transportation of Nursery Stocks - Trailer

(II) Mechanization Test (B)

Preparation of Soil for Planting - Hammer Knife Mower, Rotary Cutter, Thrasher, Rake Dozer.

Plowing - Plow, Rotary Furrow, Rotorvator

Planting hole Digging- Auger, Hole Digger

Fertilizing - Holer, Fertilizing Machine

Bush Cutting - Hammer Knife Mower, Rotorvator, Bush Cutter

Transportation of Nursery Stocks - Trailer

The work methods with the aforementioned mechanical equipments are followings:

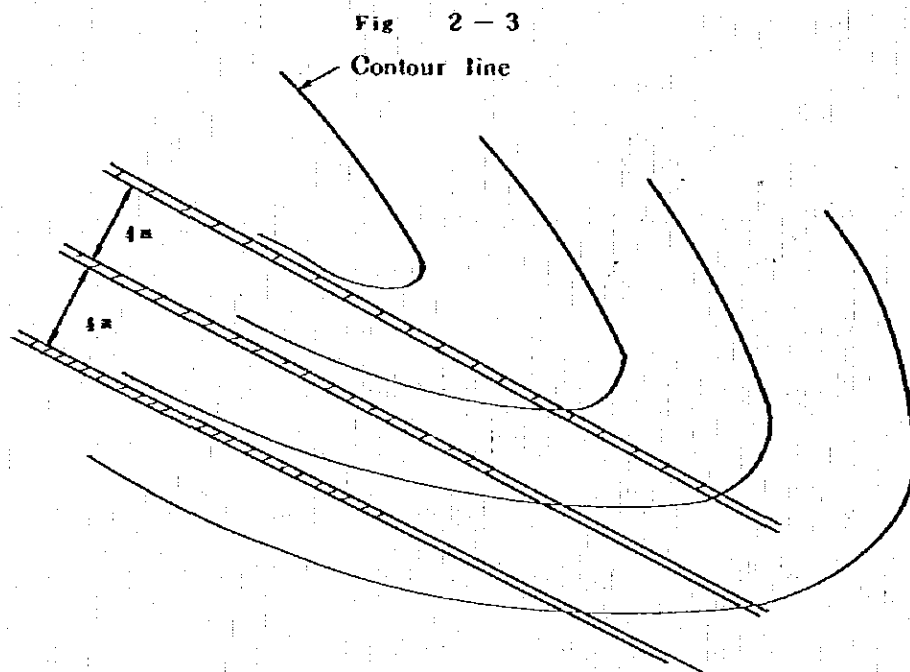
a. Preparation of Soil for Planting

The following mechanical equipments are to be used 1) The bush cutter instead of ordinary sickle. 2) Large machineries developed and utilized for farmland developments as well as tractors employing their work tools.

On preparation of soil for planting, with Bush cutters are used for stripe weeding, overall weeding, and burning after overall weeding. Trees that cannot be removed with bush cutters are cut down with chain saws.

One working team has five bush cutters and consists of nine workers. Five of them are bush cutter operators, three are their assistants and the last one is a sharpener of round sawblades.

Burning after overall weeding is accomplished by heaping weeds or shrubs with using steel rakes here and there. Large machineries are used for stripe and overall weeding. Stripe weeding with hammer knife mower, rotary thrasher, and rotary cutter are accomplished towards the lower level in gradual incline instead of along the contour lines as illustrated in Fig. 2-3 with the drainage of the forest in consideration to eliminate shrubs and Alang-Alang, etc. The clearance between the line weeding is to be 4 meters in level distance. Additionally the overall forest area is weeding with the hammer knife mower, rotary thrasher, and rotary cutter for the overall weeding.



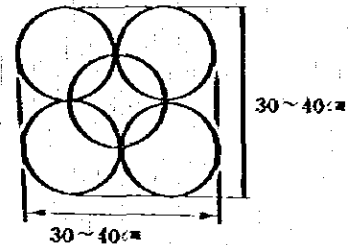
b. Plowing

Mechanization tests for plowing are performed upon completion of the tests for the preparations for planting. Rotovators, steel plows and furrows are used for plowing. Line plowing is performed with stripe weeding and overall is performed with overall weeding. A steel plow is attached to the tractor to till for about 30 to 50 cm width and 35 cm depth and to plow the Alang-Alang into the ground and then the furrow is used. Additionally, test of subsurface soil destruction and line formed closed conduit is conducted.

The subsoiler are also used to improve the permeability and ventilation of the soil.

c. Planting Hole Digging

Portable planting hole diggers are to be used. Hole diggers may be segregated into one man and two men operating models. Although the former (model) shows advanced stability than the latter (model), the efficiency of the former (model) is not significantly higher than the latter (model) for the manpower efficiency. It is more efficient to employ the former (model) as the incline in the experimental plantation area are not very steep. Hole digging works with the hole digger is to be performed in pairs. Additionally, the planting hole is about 30 to 40cm diameter and about 30cm depth and it is to be dug in sets of fives as illustrated in the figure below.



d. Planting

Pot stocks are planted in the planting hole dug with a manual step type holer (as a compact mechanized tool). The planting hole dug (out) with the holer is about 8 to 15 cm in diameter with a depth of 9 - 25cm. The planting quantity per one holer with a pair of workers is 1,200 nursery stocks a day. The pot planter a work tool connected to the rear of the tractor as a large machine. However, this unit is still in the experimental stage at present, and is intended to be improved with the employment data from the utilization in experimental plantations for future practical use. This experimental unit is operated by three crews as one driver, one pot planter and one pot loader. One team may plant 1,500 nursery stocks per day.

e. Weeding

Weeding is to be performed in one meter wide lines between the tree rows with hammer knife mowers. The proximity of the experimentally planted trees and soil improving trees are to be weeded with bush cutters.

f. Fertilizing

Fertilizers are to be buried in three to four holes dug out with a holer 20 to 30cm away from the experimentally planted tree root. The maximum hourly hole digging quantity with the holer is 1,000 holes.

The recently developed fertilizing machine enables a single worker to fertilize up to 1,000 trees a day.

2-4-3 Mechanized Nursery Stock Transportation System

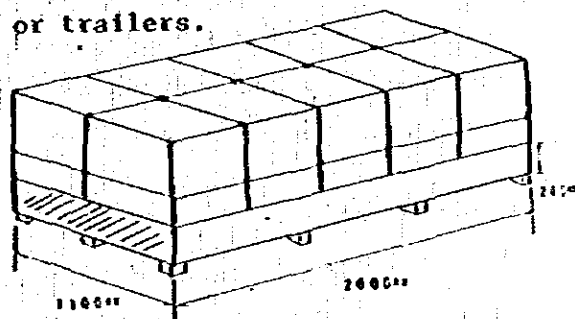
Potted stocks is to be transported with the container. The structure of the container when the diameter of the pot is 8cm is of plastics with internal dimensions of 420mm x 330mm x 320mm (height) and external dimensions of 450mm x 360mm x 320mm. The capacity of this container is 20 pots. In this case the number of containers required per ha for the individual planting density are as described below:

In case of: 2,500 tree crops per ha	125 containers
1,250 tree crops per ha	63 containers
625 tree crops per ha	32 containers

The transportation of the nursery stocks to the plantation area using containers is accomplished with the system described in the following:

20 aforementioned containers are piled in double layers of tens (2 x 5) as illustrated in Fig.2-4 on the 2,000 x 1,100 x 200mm H pallet. These are then loaded on a winch installed truck with a forklift in the nursery, and transported to the stock storage base in the plantation or directly into the plantation. The nursery stocks are transported from the storage base to the plantation site with tractor towed trailers. Empty containers are retrieved by trucks or trailers.

Fig - 2 - 4



1. Full Loaded Container Weight	27.5kg
◦ Potted Stock Weight	
1.3kg/per pot x 20 pots =	26kg
◦ Empty Container Weight	1.5kg
1. Loaded Pallet Weight	580kg
◦ Container Weight	
27.5kg/per container x 20 containers =	550 kg
Empty Pallet Weight	30kg

Which installed trucks are to be loaded with 8 pallets with 4 pallets each in the top and bottom. The height, therefore, becomes $350\text{mm} \times 2$ layers $\times 2$ steps = $1,400\text{mm}$ (1.4 meter) and the weight becomes 4 rows $\times 2 \times 550\text{kg} = 4,400\text{kg}$ (4.4 tons).

2-4-4 Design of Experiment

2-4-4-1 Study on Fertilizing

In order to examine the effects of fertilizing, a fixed plot of $50\text{m} \times 50\text{m}$ (=0.25 ha) for the fertilizing test is constructed in each test area of each experimental plantation area. Kind and numbers of plots are as follows: There are 3 kinds of plot, non-fertilizing, standard amount and 1/2 standard amount. Each of them has 2 plots and there are 6 plots in total.

A standard amount of fertilizer is N: 20 gr. per 1 tree for fast growing species and general broad leaved tree, N: 8 gr. for pines and N: 6 gr. for leguminous species. The fertilizer is polynutrient fertilizer which consists of a 13 : 17 : 12 (or 14 : 16 : 12) mixture of N, P and K, and the standard amount of fertilizer per 1 tree is as follows;

in case of the polynutrient fertilizer (13:17:12)	
for Fast growing species and general broad leaved tree	154 gr/1 tree
for Pines	62 gr/1 tree
for Leguminous species	47 gr/1 tree

Fertilizing is implemented when the survival is confirmed approximately 1 - 2 months after plantation. Since the soil of test area is infertile, continuous fertilizing for 2 - 3 years shows greater fertilizing effect. The amount of fertilizer is increased by 20% in the second year, and in the 3rd year by 20% over the 2nd year. Fertilizing is conducted by making 4 holes at a distance of 20 - 30cm from the planted tree, putting fertilizer in those holes and covering them with soil by the foot.

Concerning fixed plots for fertilizing test, total 6 plots consisting of 2 plots of non-fertilizing, 2 plots of standard amount and 2 plots of 1/2 standard amount are constructed in each test area of 4.0 ha in the case of growth test A. Also, in the case of rechanization test B, total 6 plots are constructed (each test area of 6.0 ha). In the tree species introduction test C, since the test area is as small as 1.0 ha, 6 plots, each of which is $30\text{m} \times 30\text{m}$ (=0.09 ha) size, are constructed.

Construction of plots in each test area of 3 kinds of experimental plantation area (A.B.C) is summarized in the following table.

Kind of Test	Density of Planting	Topography	Soil Improving tree	Area	Fixed Plot for Fertilizing Test				
					Non-fertilizer	Standard amount	1/2 Standard amount	Total Area	
Growth Test A	2,500 (2m x 2m)	Upper part of upland	Mixed	4	0.5	0.5	0.5	1.5	
			None	4	0.5	0.5	0.5	1.5	
		Lower part of upland	Mixed	4	0.5	0.5	0.5	1.5	
			None	4	0.5	0.5	0.5	1.5	
	1,250 (4m x 2m)	Upper part of upland	Mixed	4	0.5	0.5	0.5	1.5	
			None	4	0.5	0.5	0.5	1.5	
		Lower part of upland	Mixed	4	0.5	0.5	0.5	1.5	
			None	4	0.5	0.5	0.5	1.5	
	725 (4m x 4m)	Upper part of upland	Mixed	4	0.5	0.5	0.5	1.5	
			None	4	0.5	0.5	0.5	1.5	
		Lower part of upland	Mixed	4	0.5	0.5	0.5	1.5	
			None	4	0.5	0.5	0.5	1.5	
Total				48	6.0	6.0	6.0	18.0	
Mechanization Test B	1,250 (4m x 2m)	Upper part of upland	Mixed	6	0.5	0.5	0.5	1.5	
			None	6	0.5	0.5	0.5	1.5	
		Lower part of upland	Mixed	6	0.5	0.5	0.5	1.5	
			None	6	0.5	0.5	0.5	1.5	
	625 (4m x 4m)	Upper part of upland	Mixed	6	0.5	0.5	0.5	1.5	
			None	6	0.5	0.5	0.5	1.5	
		Lower part of upland	Mixed	6	0.5	0.5	0.5	1.5	
			None	6	0.5	0.5	0.5	1.5	
	Total				48	4.0	4.0	4.0	12.0

Kind of Test	Density of Planting	Topography	Soil Improving Tree	Area	Fixed Plot for Fertilizing Test			
					Non-fertilizer	Standard amount	1/2 Standard amount	Total Area
Tree Species Introduction Test C	2,500 (2m x 2m)	Upper part of upland	Mixed	1	0.18	0.18	0.18	0.54
			None	1	0.18	0.18	0.18	0.54
		Lower part of upland	Mixed	1	0.18	0.18	0.18	0.54
			None	1	0.18	0.18	0.18	0.54
	625 (4m x 4m)	Upper part of upland	Mixed	1	0.18	0.18	0.18	0.54
			None	1	0.18	0.18	0.18	0.54
		Upper part of upland	Mixed	1	0.18	0.18	0.18	0.54
			None	1	0.18	0.18	0.18	0.54
		Total		8	1.44	1.44	1.44	4.32

The amount of polynutrient fertilizer necessary in each test area is shown in the following table.

Kind of Test	Tree Species	Necessary Amount of Polynutrient Fertilizer		
		Standard Amount	1/2 Standard Amount	Total
Growth Test A	Fast growing species and general broad leaved tree	1,348 kg	674 kg	2,020 kg
	Pines	543	272	815
	Leguminous species	412	206	618
Mechanization Test B	Fast growing species and general broad leaved tree	578	289	867
	Pines	233	117	350
	Leguminous species	177	89	266
Tree Species Introduction Test C	Fast growing species and general broad leaved tree	347	174	521
	Pines	140	70	210
	Leguminous species	106	53	159

A study on the fertilizing contains following items.

a. Effect on soil

- Direct effects - C/N, pH(H₂O), exchange acidity, base exchange capacity, exchangeable lime, degree of saturation etc.
- Indirect effects - Thrift of weed, amount of litter

b. Effects on growth

- basal diameter
- tree height

c. Fertilizer intake rate

The test are conducted on 3 nutrients (N.P.K). However, the intake rate is calculated by using a deducting method as an expedient though it is not accurate. In the deducting method, calculation is done by deducting the intake amount on non-fertilized plot from that on fertilized plot.

2-4-4-2 Performance Study

A performance study uses non-fertilized fixed plots which have been constructed in the study on the fertilizing test described before. Besides, in the test areas of 1 - 2 ha which are located in each compartment of 3 experimental plantation areas, a fixed plot of 50m x 50m (=0.25 ha) is constructed.

A performance study is conducted on the following items.

- a. Rate of mortality (rate of survival)
- b. Tree height - average, maximum, minimum
- c. Diameter breast high or basal diameter - average, maximum, minimum.
- d. Appearance of fox tails concerning *P. caribaea*.

2-4-4-3 Study on Mechanized Process

The final purpose of mechanization test is the effective expansion of plantation by introducing of machines.

In order to obtain basic data for the above purpose, following analysis is implemented.

- a. **Process analysis** - By pursuing the flow of materials, the change of moving and working conditions in each process are recorded to analyse the productivities, procedure and time. Then, based on the analysis, the management of process, transportation and equipments will be judged in order to improve and standardize the production process.
- b. **Time analysis** - Regarding workers or machines, changes of each work element and various conditions in course of work are measured with the lapse of time and aggregated to know the main elements of working methods and conditions. And the obtained results are used as basic data for the improvement and standardization of work.
- c. **Action analysis** - Character of each action is examined by analyzing of work elements. And based on the observation of workers posture and the way how they move their arms and legs, less fatigating working actions are designed by eliminating useless actions and improving work methods. The purpose of this action analysis is to raise work efficiency by reducing wasted time.

After investigating hoco the work efficiency is raised using above work analysis, simplification and speeding up of the working method are planned.

2-4-5 Work Plan

Outline of the work plan of land preparation, planting, fertilizing and weeding at 3 experimental plantation areas from the year 1980/1981 (2nd year) till 1984/1985 (6th year) is shown in the table 2-3.

Weeding is to be done 3 times in the 1st year, twice in the 2nd year and once in the 3rd year.

Areas of 3 experimental plantation areas by year is as follows.

A. Plantation area for growth test (1000 ha)

A₁ 200 ha, A₂ 200 ha
A₃ 300 ha, A₄ 300 ha

B. Plantation area for mechanization test (850 ha)

B₁ 150 ha, B₂ 300 ha, B₃ 400 ha

C. Plantation area for tree species introduction test (250 ha)

C₁ 50 ha, C₂ 100 ha, C₃ 100 ha

Table 2-3 WORK PLAN

	1980/1981												1981/1982												1982/1983												1983/1984												1984/1985																																																																							
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12																																																												
A Growth Test	Preparation of Soil A ₁												Planting A ₁												Weeding A ₁												Weeding (1st year) A ₁												Weeding (2nd year) A ₁												Preparation of Soil A ₁												Planting A ₁												Weeding A ₁												Weeding (1st year) A ₁												Weeding (2nd year) A ₁											
B Mesozoa Test	Preparation of Soil B ₁												Planting B ₁												Weeding B ₁												Weeding (1st year) B ₁												Weeding (2nd year) B ₁												Preparation of Soil B ₁												Planting B ₁												Weeding B ₁												Weeding (1st year) B ₁												Weeding (2nd year) B ₁											
C Free Species Test	Preparation of Soil C ₁												Planting C ₁												Weeding C ₁												Weeding (1st year) C ₁												Weeding (2nd year) C ₁												Preparation of Soil C ₁												Planting C ₁												Weeding C ₁												Weeding (1st year) C ₁												Weeding (2nd year) C ₁											

Notes: 1) Planting area by year A-Block - A₁ 200m A₂ 200m A₃ 300m A₄ 300m Total 1000m
 B-Block - B₁ 150m B₂ 300m B₃ 400m Total 850m
 C-Block - C₁ 50m C₂ 100m C₃ 100m Total 250m

2) Weeding in 1st year is included replanting.

2-5 Stock Nursing Plan

The stock nursing plan based on the aforementioned (3) experimental (plantation) execution plan is as listed in the following:

(1) 1980/1981 - 351,250 Nursery Stocks

Variation	Species	Area	Number of Nursery Stocks per Ha	Number of Nursery Stocks	Total Number of Nursery Stocks
Growth Increment Test (A)	<i>P. merkusii</i>	16 ha	2,500	40,000	72,000
		16	1,250	20,000	
		16	625	10,000	
		2	1,250	2,500	
	<i>A. falcata</i>	16	2,500	40,000	72,000
		16	1,250	20,000	
		16	625	10,000	
		2	1,250	2,500	
	<i>S. macrophylla</i>	16	2,500	40,000	71,250
		16	1,250	20,000	
		16	625	10,000	
		1	1,250	1,250	
		1	Direct Sowing	-	
	<i>E. deglupta</i>	16	2,500	40,000	72,500
		16	1,250	20,000	
		16	625	10,000	
		2	1,250	2,500	
	<i>L. glauca</i> (4 Tree Species Worth)	100	625	62,500	62,500

(ii) 1981/1982 - 634,375 Nursery Stocks

Variation	Species	Area	Number of Nursery Stocks per Ha	Number of Nursery Stocks	Total Number of Nursery Stocks
Growth Increment Test (A)	<i>A. auriculaeformis</i>	16 ha	2,500	40,000	72,500 Pcs
		16	1,250	20,000	
		16	625	10,000	
		2	1,250	2,500	
	<i>S. bancana</i>	16	2,500	40,000	71,250
		16	1,250	20,000	
		16	625	10,000	
		1	1,250	1,250	
		1	Direct Sowing	-	
	<i>P. canescens</i>	16	2,500	40,000	71,250 41,250 Section for Direct Slip Planting
		16	1,250	20,000	
		16	625	10,000	
		1	1,250	1,250	
		1	1,250 Direct Slip Planting	1,250	
	<i>A. cadamba</i>	16	2,500	40,000	72,500
		16	1,250	20,000	
16		625	10,000		
2		1,250	2,500		
<i>L. glauca</i> (4 Tree Species Worth)	100	625	62,500	62,500	
(B)	<i>P. merkusii</i>	24	1,250	30,000	47,500
		24	625	15,000	
		2	1,250	2,500	

Variation	Species	Area	Number of Nursery Stocks per Ha	Number of Nursery Stocks	Total Number of Nursery Stocks
Mechanization Test (B)	A. falcata	24	1,250	30,000	47,500 Pcs
		24	625	15,000	
		2	1,250	2,500	
	E. deglupta	24	1,250	30,000	47,500
		24	625	15,000	
		2	1,250	2,500	
	L. glauca (3 Species Worth)	75	625	46,875	46,875
Tree Species Introduction Test (C)	5 Species Worth	25	2,500	62,500	78,125
		25	625	15,625	
	L. glauca (5 Species Worth)	25	625	15,625	15,625

(iii) 1982/1983 - 1,092,500 Nursery Stocks

Variation	Species	Area	Number of Nursery Stocks per Ha	Number of Nursery Stocks	Total Number of Nursery Stocks
Growth Increment Test (A)	P. merkusii	50 ha	The same as 1980/1981		72,500
	A. falcata	50	"		72,500
	S. macrophylla	50	"		(Note 1) 71,250
	E. deglupta	50	"		72,500
	S. bancana	50	The same as 1981/1982		(Note 1) 71,250
	A. cadamba	50	"		72,500
	L. Glauca (6 Species Worth)	150	625	93,750	93,750

Variation	Species	Area	Number of Nursery Stocks per Ha	Number of Nursery Stocks	Total Number of Nursery Stocks
Mechanization Test (B)	P. merkusii	50 ha	The same as 1981/1982		47,500 Po's
	A. falcata	50	"		47,500
	S. macrophylla	24	1,250	30,000	47,500
		24	625	15,000	
		2	1,250	2,500	
	E. deglupta	50	The same as 1981/1982		47,500
	A. auriculae formis	24	1,250	30,000	47,500
		24	625	15,000	
		2	1,250	2,500	
	S. bancana	24	1,250	30,000	47,500
24		625	15,000		
2		1,250	2,500		
Tree Species Introduction Test (C)	L. Glauca (6 Species Worth)	150	625	93,750	93,750
	10 Species Introduction Test (C)	50	2,500	125,000	156,250
		50	625	31,250	
	L. glauca (10 Species Worth)	50	625	31,250	31,250

(iv). 1983/1984 - 1,218,750 Nursery Stocks

Variation	Species	Area	Number of Nursery Stocks per Ha	Number of Nursery Stocks	Total Number of Nursery Stocks
Growth Increment Test (A)	P. merkusii	50 ha	The same as 1980/1981		72,500 Po's
	A. falcata	50	"		72,500
	S. macrophylla	50	"		71,500
	E. deglupta	50	"		72,500
	S. bancana	50	The same as 1981/1982		71,250

Variations	Species	Area	Number of Nursery Stocks per Ha	Number of Nursery Stocks	Total Number of Nursery Stocks
Mechanization Test (B)	A. cadamba	50 ha	The same as 1981/1982		Pe's 72,500
	L. glauca (6 Species Worth)	150	"		93,750
	P. merkusii	50	"		47,500
	A. falcata	50	"		47,500
	S. macrophylla	50	The same as 1982/1983		47,500
	E. deglupta	50	The same as 1981/1982		47,500
	A. auriculae formis	50	The same as 1982/1983		47,500
	S. bancana	50	"		47,500
	P. canescens	24	1,250	30,000	47,500
		24	625	15,000	
	2	1,250	2,500		
	A. cadamba	24	1,250	30,000	47,500
		24	625	15,000	
		2	1,250	2,500	
	L. glauca (8 Species Worth)	200	625	125,000	125,000
Tree Species Introduction Test (C)	10 Species Worth	100	The same as 1982/1983		156,250
	L. glauca (10 Species Worth)	50	"		31,250

Note 1 Except 1,250 direct sowings per ha.

Note 2 Direct sowed G. Arborea trees and soil improving trees for the Giant Ipil-ipil in the tree species introduction test are included.

The annual total numbers of nursery stocks for each stock types are as listed in the following:

Year	Necessary Number of Nursery Stock				Total Number of Stocks	Nursery Number of Stock Production
	Normal Stock	Stump Stock	Cultivated Cutting	Scion		
1980/1981	280,000	71,250	-		351,250	439,100
1981/1982	490,625	71,250	71,250	1,250	634,375	791,500
1982/1983	839,375	*253,125	-	-	1,092,500	1,365,700
1983/1984	933,750	237,500	47,500	-	1,218,750	1,523,500
Total	2,543,750	633,125	118,750	1,250	3,296,875	4,119,800

* Stump stocks of the G. Arboree for the species introduction test are included into the 1982/1983 project.

** Scions are not included into the stock production quantity. Furthermore, the annual necessary number of stocks for each species are as in chart .

Annual Required for Each Tree Species

Variation	Species	Year				Remarks
		1980/1981	1981/1982	1982/1983	1983/1984	
Growth Increment Test (A)	P.merkusii	72,500		72,500	72,500	
	A.falcata	72,500		72,500	72,500	
	S.macrophylla	71,250		71,250	71,250	
	E.deglupta	72,500		72,500	72,500	
	A.auriculaeformis		72,500			
	S.bancana		71,250	71,250	71,250	
	P.canescens		*72,500			* Including 1,250 Scions for Direct Slip Planting
	A.cadamba		72,500	72,500	72,500	
	L.glauca	62,500	62,500	93,750	93,750	
	Total	351,250	351,250	526,250	526,250	

Variation	Species	Year				Remarks
		1980/1981	1981/1982	1982/1983	1983/1984	
Mechanization Test (B)	P.merkusii		47,500	47,500	47,500	
	A.falcata		47,500	47,500	47,500	
	S.macrophylla			47,500	47,500	
	E.deglupta		47,500	47,500	47,500	
	A.auriculaeformis			47,500	47,500	
	S.bancana			47,500	47,500	
	P.canescens				47,500	
	A.cadamba				47,500	
	L.glauca		46,875	93,750	125,000	
	Total		189,375	378,750	505,000	
Tree Species Introduction Test (C)	5 Species		78,125			
	10 Species			156,250		
	10 Species				156,250	
	L.glauca		15,625	31,250	31,250	
	Total		93,750	187,500	187,500	
	Annual Total	351,250	634,375	1,092,500	1,218,750	
	Grand Total		3,296,875			

2-6 Labor and Cost

2-6-1 Work Step per Ha

a. Incrementation Test A and Tree Species Introduction Test C

Item	Work Step per Laborer per Day	Labor			Remarks
		2500 (2m x 2m)	1250 (4m x 2m)	625 (4m x 4m)	
Land preparation	1000 m ²	Laborer/Day 5.0	Laborer/Day 2.5	Laborer/Day 2.5	1 m wide line weeding with brush cutter
Plant Hole Digging	440	5.7	2.9	1.5	Digging with an auger 5 times digging per one seedling with 2 laborers
Planting	600	4.2	2.1	1.1	With holer
Fertilization	1000	2.5	1.3	0.7	With holder or fertilizing machine
Weeding	1000 m ²	5.0	2.5	2.5	1 m wide line weeding with bush cutter

b. Mechanization Test B

Item	Work Step per Laborer per Day	Labor			Remarks
		2500 (2m x 2m)	1250 (4m x 2m)	625 (4m x 4m)	
Land preparations	5000 m ²	1.0	0.5	0.5	Hammer Knife Hower (a) 1 m wide line weeding 2 laborers/8 hours
	16000 m ²	0.4	0.2	0.2	Rotary Cutter (b) 1 m wide line weeding 2 laborers/8 hours
Plowing	32000 m	0.2	0.1	0.1	With Plow 2 laborers/8 hours

Item	Work Step per Laborer per Day	Labor			Remarks
		2500 (2m x 2m)	1250 (4m x 2m)	625 (4m x 4m)	
Plant Hole Digging	440	5.7	2.9	1.5	With Auger 2 laborers/5 times digging per one seedling
Planting	600	4.2	2.1	1.1	With Holer (c)
	1500	1.7	0.9	0.5	Pot stock planter (d) 3 laborers
Fertilization	1000	2.5	1.3	0.7	With Holer or Fertilizing Machine
Weeding	5000 m ²	1.0	0.5	0.5	Hammer Knife Mower (Joint use of brush cutters excluded)

2-6-2 Labor per Forest Compartment

a. Incrementation Test A (50 ha)

Land preparation	165.0 man.day	} Planting Total: 629.1 man.day
Plant Hole Digging	167.4 man.day	
Planting	122.6 man.day	
Planting Position Indication	174.1 man.day	
Fertilization	17.5 man.day	
Weeding	165.0/ (3rd year) 189.5 (1st and 2nd year/Supplementary planting included)	
Planting with Soil Improving Tree	99.2 man.day	

b. Mechanization Test E(50 ha)

Land preparation	a) 25.0 man.day b) 10.0 man.day	} Total	Planting	
Plowing	5.0 man.day		a) and b)	336.5 man.day
Plant Hole Digging	111.4 man.day		a) and d)	290.9 man.day
Planting	c) 81.0 man.day d) 35.4 man.day		b) and c)	321.5 man.day
Planting Position Indication	114.1 man.day		b) and d)	275.9 man.day
Fertilization	7.5 man.day			
Weeding	25.0/ 41.2 man.day		(3rd year) Hammer Knife Mower (1st and 2nd year/Supplementary planting included) Hammer Knife Mower	
Soil Improving Tree Planting	99.2 man.day			

c. Tree Species Introduction Test C (10 ha)

Land preparation	40.0 man.day	} Total: 151.9 man.day	Planting	
Plant Hole Digging	40.2 man.day			
Planting	29.6 man.day			
Planting Position Indication	42.1 man.day			
Fertilization	4.5 man.day			
Weeding	40.0/ 45.9 man.day		(3rd year) (1st and 2nd year/supplementary planting included)	
Planting with Soil Improving Tree	19.8 man.day			

2-6-3 Annual Labor and Cost

a. 1980/1981

Item	Area	Labor per Forest Compartment	Total Labor	Cost
Planting on A Block (A ₁)	200 ha	629.1 Man.day/50 ha	2516.4 Man	3,019,680 Rp
Fertilization on A Block(A ₁)	200	17.5	70.0	84,000
Planting With Soil Improving Tree	100	99.2	198.4	238,080
Total			2784.8 Man	3,341.760

b. 1981/1982

Item	Area	Labor per Forest Compartment	Total Labor	Cost
Planting on A Block(A ₂)	200 ha	629.1 Man.day/50 ha	2516.4 Man	3,019,680 Rp
Fertilization on A Block(A ₂)	200 ha	17.5	70.0	84,000
Planting with Soil Improving Tree	100	99.2	198.4	238,080
First Year Weeding (Three times) on A Block(A ₁)	600	189.5	2274.0	2,728,800
Sub Total			5,058.5	6,070,560
Item	Area	Labor per Forest Compartment	Total Labor	Cost
Planting on B Block (B ₁)	150 ha	336.5 Man.day/50 ha	1,009.5Man	1,211,400
Fertilization on B Block(B ₁)	150	7.5	22.5	27,000
Planting with Soil Improving Tree	75	99.2	148.8	178,560
Sub Total			1,180.8	1,416,960

Item	Area	Labor per Forest Compartment	Total Labor	Cost
Planting on C Block (C ₁)	50 ha	151.9 Man.Day/ 50 ha	759.5 Man	911,400 Rp
Fertilization on C Block (C ₁)	50	4.5	22.5	27,000
Planting with Soil Improving Tree	25	19.8	49.5	59,400
Sub Total			831.5 Man	997,800
Total			7,071.1 Man	8,485,320

c. 1982/1983

Item	Area	Labor Forest Compartment	Total Labor	Cost
Planting on A Block (A ₃)	300 ha	629.1 Man.Day/ 50ha	3,774.6 Man	4,529,520 Rp
Fertilization on A Block (A ₃)	300	17.5	105.0	126,000
Planting with Soil Improving Tree	150	99.2	297.6	357,120
First Year Weeding (Three Times) on A Block (A ₂)	600	189.5	2,274.0	2,728,800
A Second Year Weeding (twice)	400	189.5	1516.0	1,819,200
Sub Total			7,967.2	9,560,640
Planting on B Block (B ₂)	300	336.5	2,019.0	2,422,800
Fertilization on B Block (B ₂)	300	7.5	45.0	54,000
Planting with Soil Improving Tree	150	99.2	297.6	357,120
First Year Weeding (three Times) on B Block (B ₁)	450	41.2	370.8	444,960
Sub Total			2,732.4	3,278,880

Item	Area	Labor per Forest Compartment	Total labor	Cost
Planting on C Block (C ₂)	100 ha	141.9 Man.Day/ 50 ha	1,519.0 Man	1,822,800 Rp
Fertilization on C Block (C ₂)	100	4.5	45.0	54,000
Planting with Soil Improving Tree	50	19.8	99.0	118,800
On C Block First Weeding (Three Times) (C ₁)	150	45.9	688.5	826,200
Sub Total			2,351.5	2,821,800
Total			13,051.1	15,661,320

d. 1983/1984

Item	Area	Labor per Forest Compartment	Total labor	Cost
Planting on A Block (A ₄)	300 ha	629.1 Man.Day/ 50 ha	3,774.6 Man	4,529,520 Rp
Fertilization on A Block (A ₄)	300	17.5	105.0	126,000
Planting with Soil Improving Tree	150	99.2	297.6	357,120
First Year Weeding on A Block (Three Times)(A ₃)	900	189.5	3,411.0	4,093,200
A ₁ Third Year Weeding (Once)	200	165.0	660.0	792,000
A ₂ Second Year Weeding(Twice)	400	189.5	1,516.0	1,819,200
Sub Total			9,764.2	11,717,040

Item	Area	Labor per Forest Compartment	Total Labor	Cost
Planting on B Block (B ₃)	400 ha	336.5 Man, Day/50 ha	269.2 Man	3,230,400 Rp
Fertilization on B Block(B ₃)	400	7.5	60.0	72,000
Planting With Soil Improving Tree	200	99.2	396.8	476,160
First Year Weeding (Three Times) on B Block(B ₂)	900	41.2	741.6	889,920
B ₁ Second Year Weeding(Twice)	300	41.9	247.2	296,640
Sub Total			1,714.8	2,057,760
Planting on C Block (C ₃)	100	151.9	1,519.0	1,822,800
Fertilization on C Block(C ₃)	100	4.5	45.0	54,000
Planting with Soil Improving Tree	50	19.8	99.0	118,800
First Year Weeding (Three Times on C Block) (C ₂)	300	45.9	1,377.0	1,652,400
C ₁ Second Year Weeding(Twice)	100	45.9	459.0	550,800
Sub Total			3,499.0	4,198,800
Total			4,978.0	17,973,600

e. 1984/1985

Item	Area	Labor per Forest Compartment	Total Labor	Cost
A ₁ Third Year Weeding (Once)	200 ha	165.0 Man. Day/50 ha	660.0 Man	792,000 Rp
A ₂ Second Year Weeding (Twice)	600	189.5	2,274.0	2,728,800
A ₃ First Year Weeding (Three Times)	900	189.5	3,411.0	4,093,200
Sub Total			6,345.0	7,614,200
B ₁ Third Year Weeding (Once)	150	25.0	75.0	90,000
B ₂ Second Year Weeding (Twice)	600	41.2	494.4	,593,280
B ₃ First Year Weeding (Three Times)	1,200	41.2	988.8	1,186,560
Sub Total			1,558.2	1,869,840
C ₁ Third Year Weeding (Once)	50	40.0	200.0	240,000
C ₂ Second Year Weeding (Twice)	200	45.9	918.0	1,101,600
C ₃ First Year Weeding (Three Times)	300	45.9	1,377.0	1,652,400
Sub Total			2,495.0	2,994,000
Total			10,398.2	12,477,840

f. 1985/1986

Item	Area	Labor Per Forest Compartment	Total labor	Cost
A ₃ Third Year Weeding (3 rd Once)	300 ha	165.0 Man.Day/50 ha	990.0 Man	1,188,000 Rp
A ₄ Second Year Weeding	600	189.5	2,274.0	2,728,800
Sub Total			3,264.0	3,916,800
B ₂ Third Year Weeding (2 nd Once)	300	25.0	150.0	180,000
B ₃ Second Year Weeding	800	41.2	659.2	791,040
Sub Total			809.2	971,040
C ₂ Third year Weeding (2 nd Once)	100	40.0	400.0	480,000
C ₃ Second Year Weeding	200	45.9	918.0	1,101,600
Sub Total			1,318.0	1,581,600
Total			5,391.2	6,469,440

g. 1986/1987

Item	Area	Labor per Forest Compartment	Total Labor	Cost
A ₄ Third Year Weeding (1 st Once)	300 ha	165.0 Man.Day/50 ha	990.0 Man	1,188,000 Rp
B ₃ Third Year Weeding (3 rd Once)	400	25.0	200.0	240,000
C ₃ Third Year Weeding	100	40.0	400.0	480,000
Total			1,590.0	1,908,000

The funds projected for the period between fiscal years 1980/1981 thru 1986/1987 is for the planting(preparation for planting/ plowing/plant hole digging/ planting/ plant position identification), fertilizing(first year only)weeding(three times in the first year/ twice in the second year/ once in the third year,)and planting with soil improvingtree. The daily labor cost was computed at Rp 1,200 per laborer.

Total labor and cost from 1980/1981 to 1986/1987 is shown in the following table.

Year	Total labor	Cost
1980/1981	2,784.8	3,341,760
1981/1982	7,071.1	8,485,320
1982/1983	13,051.1	15,661,320
1983/1984	14,978.0	17,973,600
1984/1985	10,398.2	12,477,840
1985/1986	5,391.2	6,469,440
1986/1987	1,590.0	1,908,000
Total	55,264.4	66,317,280

2-6-4 Plantation Field Office Related Cost

Individual work supervisors, maintenance and management staff for the fire protection belt, patrolmen and seedling transporters, etc,are the staff of plantation field office.

2-7 Planning of attached facilities such as machine house etc.

Following facilities are constructed on the site for facilities of 3.0 ha in the experimental plantation land.

(i) Plantation field office

Comprehensive management of planting and nursing work is under the jurisdiction of the management office which will be constructed in the nursery, and control of each planting work is handled by the plantation field office.

(ii) Storehouse

Tools, materials and small machines (brush cutter, chainsaw, holer, anger, fertilizing machine etc.) used for planting work are stored.

(iii) Machine house

Planting machines and various attachments are placed.

(iv) Meeting house

Workers gather and hold meeting at this

(v) Fertilizer house

Fertilizers used for planting are stored.

(vi) Generator house

Power generators used in various facilities are stored.

Layout of these facilities is shown in Fig. 2-5. Sizes of each facility are shown in Fig. 2-6 to Fig. 2-11.

Fig 2 - 5 PLAN OF FACILITIES AREA
IN TRIAL PLANTING SITE

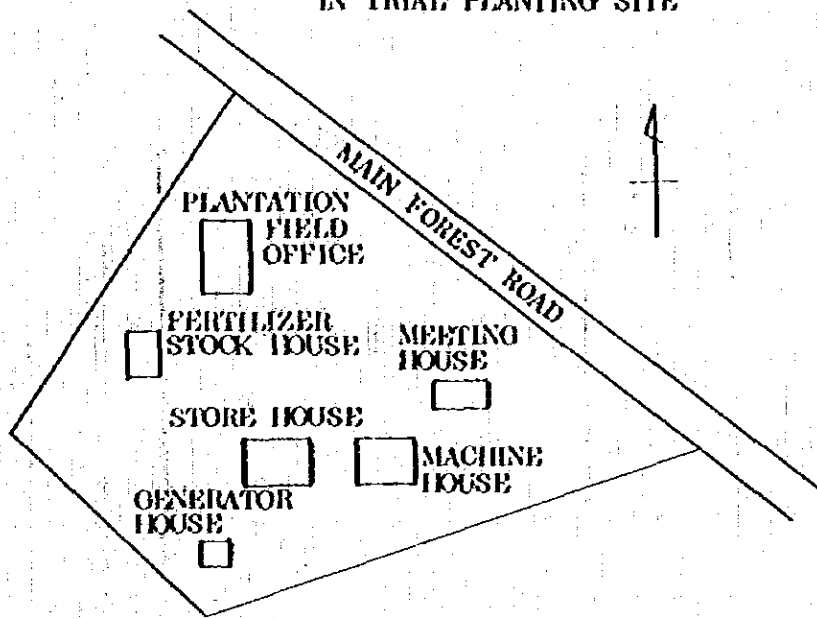


FIG 2 - 6 PLANTATION FIELD OFFICE

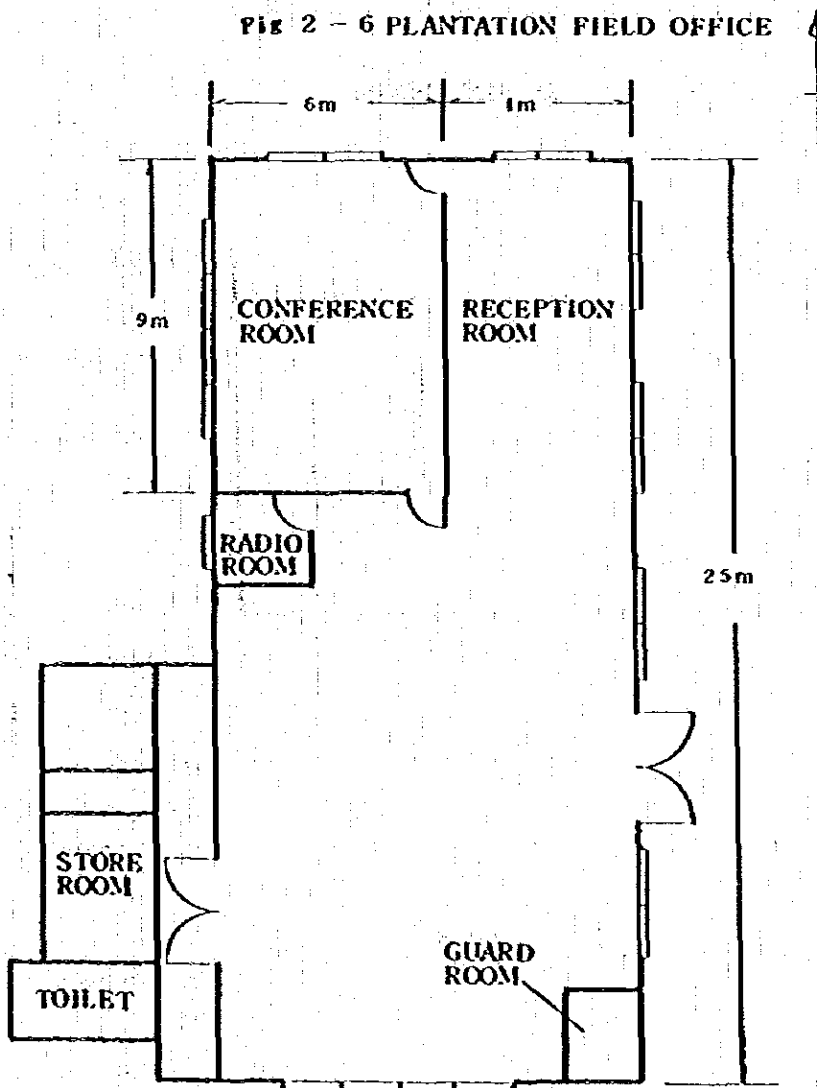


Fig 2 - 7 STORE HOUSE

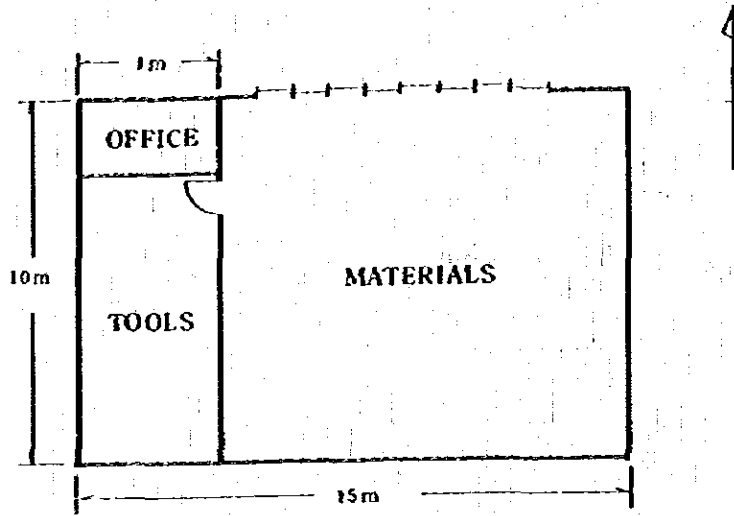


Fig 2 - 8 MACHINE HOUSE

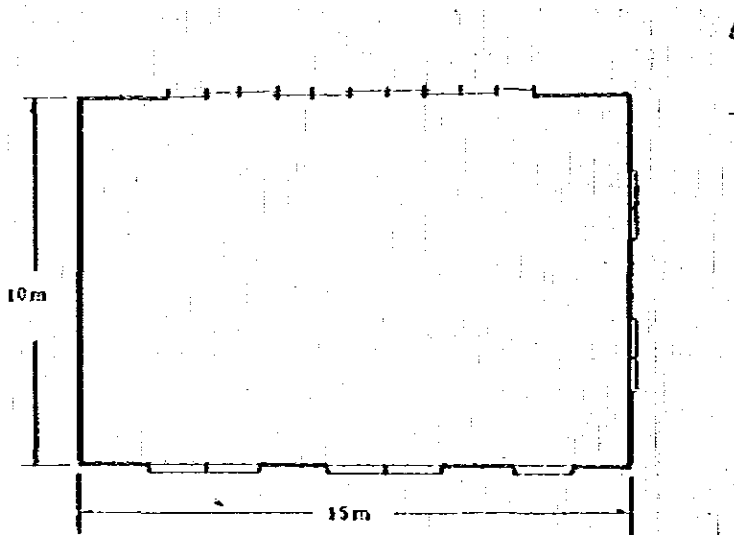


Fig 2-9 MEETING HOUSE

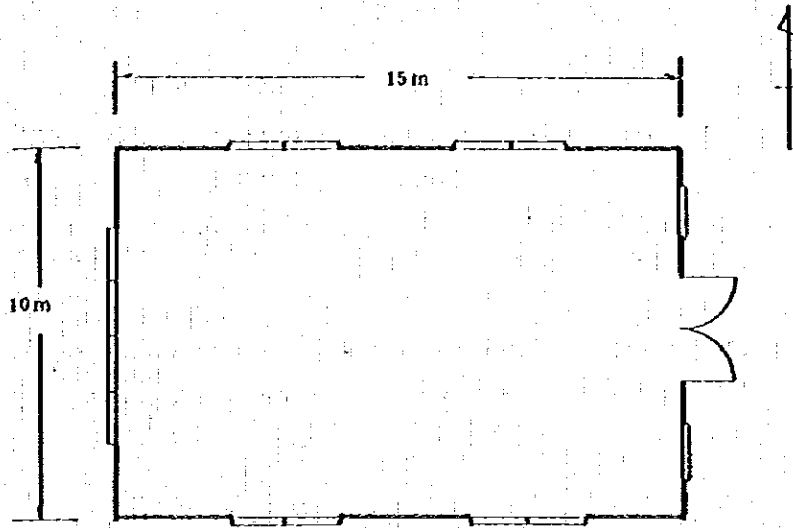


Fig 2-10 FERTILIZER HOUSE

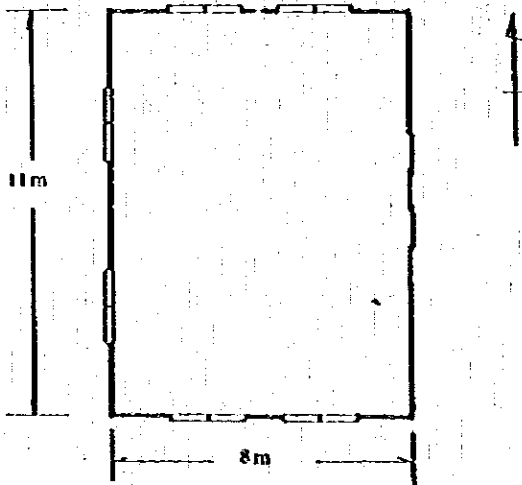
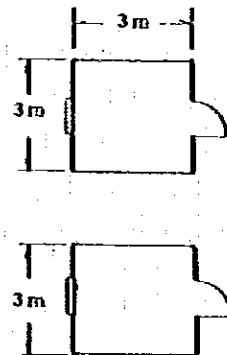


Fig 2-11 GENERATOR HOUSE



3. Nursery Construction Plan

3-1 Basic Concept

The basic concept of nursery construction is as follows;

1. The nursery stocks to be used for this experimental plantation should be all grown in the self-owned nursery. The production ability of the nursery, therefore, should be sufficient enough to provide the maximum amount of nursery stocks necessary for this experimental plantation.

2. Since this experimental plantation also aims at making a model of mechanized silviculture, the construction and operation of the nursery also should be done by machinery.

3. The nursery should be made into a fixed nursery so that mechanized practice can be done. The nursery field should be flat for the convenience of testing and research activities.

4. At the site of the nursery, administration facilities such as a administration office and accommodation buildings for engineers as well as the facilities needed for nursery practice itself will be built.

3-2 Nursery Stock Production Plan

The necessary amount of nursery stocks by year in this experimental plantation plan is shown and explained in Chapter 3.

Accordingly, the production number of nursery stocks by year (based on an out-planting rate of 80%) is shown in Table 3-1.

The major species to be used are potted nursery stocks but stumps are used for Mahogany and cuttings for sunkai mainly.

Table 3-1 Production amount of nursery stocks by year

Amount of nursery stocks for out-planting			
Year	Species	Out-planting number	Production number
1	None	0	0
2 (1980/81)	Merkusii Pine	72,500	90,600
	Albizzia	"	"
	Deglupta Eucaly	"	"
	Mahogani	71,250	89,200
	Soil improving tree	62,500	78,100
	Total	351,250	439,100
3 (1981/82)	The five species above	267,500	334,400
	Auriculaeformis	72,500	90,600
	Bancana	71,250	89,100
	Sunkai	72,500	"
	Anthocephalus	"	90,600
	Others	78,125	97,700
	Total	634,375	791,500
4 (1982/83)	The nine species above and others	1,092,500	1,366,700
5 (1983/84)	Same as above	1,212,750	1,523,500

3-3 Nursery Construction Plan

3-3-1 Contemplated Site for Construction

The area where was formerly used as a nursery and is on the west bank of the River Baun (refer to Fig. 1-1), approximately 12 km west from Pendopo, is desirable for this nursery.

In general, the factors that should be considered before deciding on a nursery site are 1. irrigation 2. the distance from the site of

afforestation 3. sufficient space 4. labor power 5. soil, among others. After considering these factors, the above site has the following advantages and disadvantages:

1. Water can be irrigated from the River Baung all year around.
2. The site is only 2 km away from the afforestation site, and there is Stan. Vac. road which can be used for commuting between the nursery site and afforestation site. Therefore, construction of new roads is necessary only in the nursery site.
3. The site is located on gradually rising hills, and just by preparing the soil it can be easily made into a field with efficient drainage.
4. A labor power can be received either from Baung Village on the east bank of River Baun or Benakat Village in the neighborhood of the contemplated site for afforestation.
5. It is not easy to obtain soil, sand and ballast, which is a problem.
6. Since the site is close to villages, there are apprehensions of robbery and other disturbances.
7. There is no problem concerning the right of using the land.

Taking into account the above points, we find the site adequate for a nursery.

As for the difficulty of obtaining sand and ballast, we would have similar problems wherever we set the site in this region since no ballast can be obtained from the river and no rocky mountains exist. Sand and ballast will be used only in small amounts for aggregate upon construction of the nursery and also for mixing with soil to be used in the germination bed. This problem, therefore, can be solved by purchasing sand and ballast from nearby such as Pendopo.

As a countermeasure to getting soil, there are two alternative plans, which require further examination.

Plan 1: Collect and pile the surface soil gained from the nursery construction.

Plan 2: Bring the ando soil over from the Benakat region, approximately 25 km east from Pendopo.

The details, such as the possible collecting of ando soil and legal problems concerning the property of the land, could not be obtained during our recent investigation, and further investigation is required as to these matters.

In order to prevent the problems cited in 7, an effort to cooperate with the people living in the host region is vital.

3-3-2 The Environment and the Present Condition of the Contemplated Site of Nursery

The site is 16.5ha and is on the north side of the Stan. Vac. road, on the west bank of River Baung. (Refer to Fig. 3-1)

The existing brushland between the road and the nursery site should be kept as a buffer zone 50m wide. The land is estimated to be between 60 and 70m above the sea-level. The height of undulations are within 13m at the nursery site.

On the west side of the site there are hills from the north to the south, which have two branches running towards the east, in the direction of the River Baun. There are several creeks running into the River Baung, and during the rainy season a part of the east side of the site, including these creeks, may be flooded.

The site is presently covered with bush and other trees of which height is around 5 or 6m. On the bank of the River Baung and also in the northwest part of the site there are gum plantations, and it will be necessary to purchase a part of the plantation on the bank of the River Baung to be used for a site for facilities.

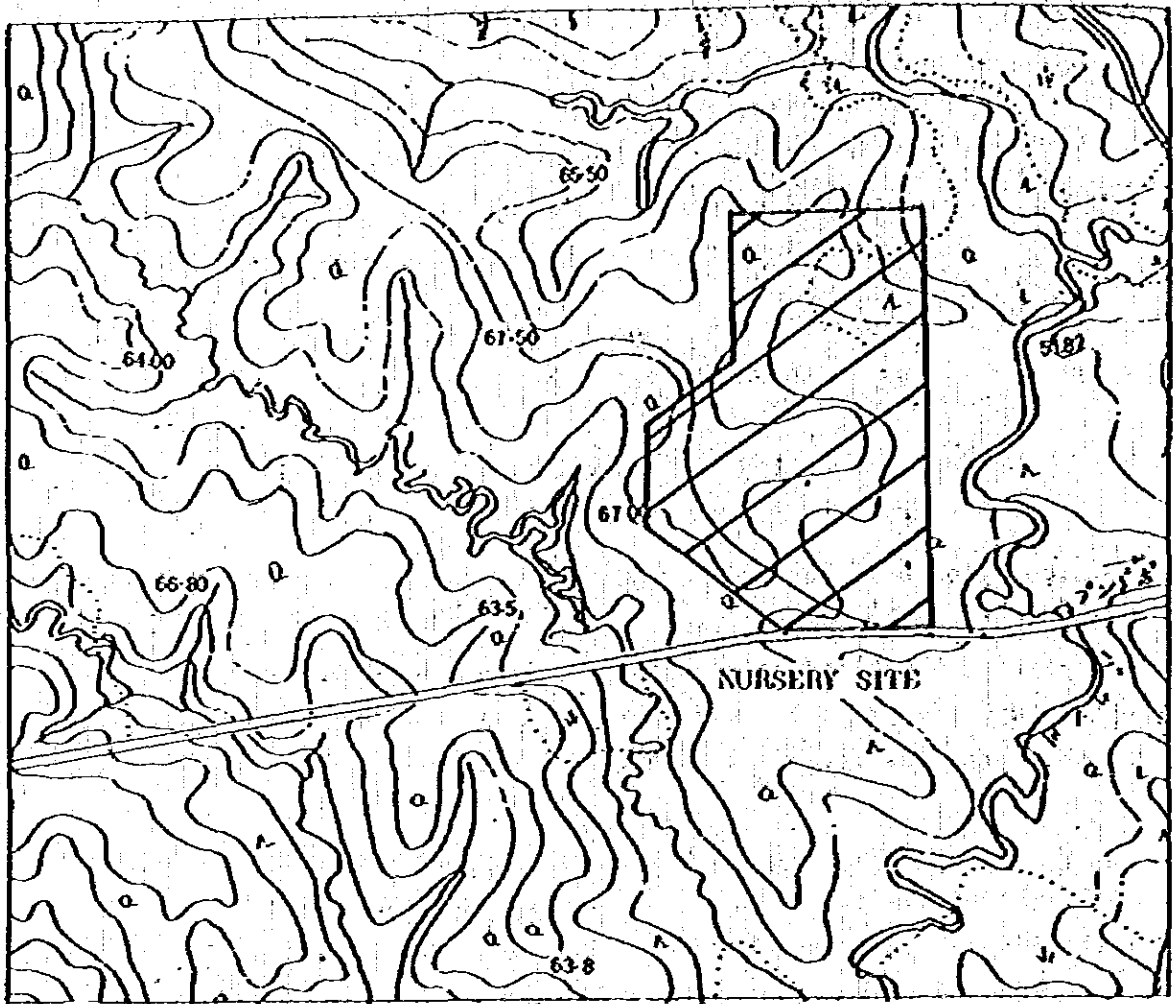
3-3-3 Nursery Related Facilities and their Placement

The necessary facilities for the nursery are as follows:

1. Operation facilities:

Nursery field, working area, warehouses, reservoir, etc.

Fig 3 - 1 NURSERY SITUATION MAP



Scale 1:10,000

The rising part of the land running towards the east from the center of the nursery site will be used for these facilities after preparing the land.

2. Administration facilities:

A administration office, laboratory, training room, accomodation facilities, etc. These facilities will be built on the hills in the west and north part of the nursery site.

3. Annexes:

A road leading into the nursery spur roads, a sample plantation, shelter belts, etc. For the sample plantation and shelter belts, the trees in spaces other than the construction sites for the above facilities will be kept.

The placement of the facilities is shown in Fig. 3-2.

The following are the details of the facilities:

1. Operation facilities

- 1-1 Nursery field: 3.5hr. In order to make drainage better, the field should incline 2° towards the east and 3° towards the north and south and its surface should be flat. It will be used for outdoor seeding and nursery practice. It should be equipped with germination beds, nursery beds, irrigation and drainage facilities and sun shades.
- 1-2 Working area: 500 square meters, will be built at the east end of the field and contain a germination room for indoor seeding and nursery practice, a soil depository, a soil heating area, potting room for seeding transplanting and a potted seedlings depository. (Refer to Fig. 3-3)
The germination room should be equipped with sun shades and irrigation facilities, and it should be constructed so as to have good ventilation.
- 1-3 Reservoir and a dam: The size of the reservoir should be $20m \times 15m \times 3m$. It will be constructed on the bank of the

Fig 3 - 2 PLAN OF NURSERY SITE

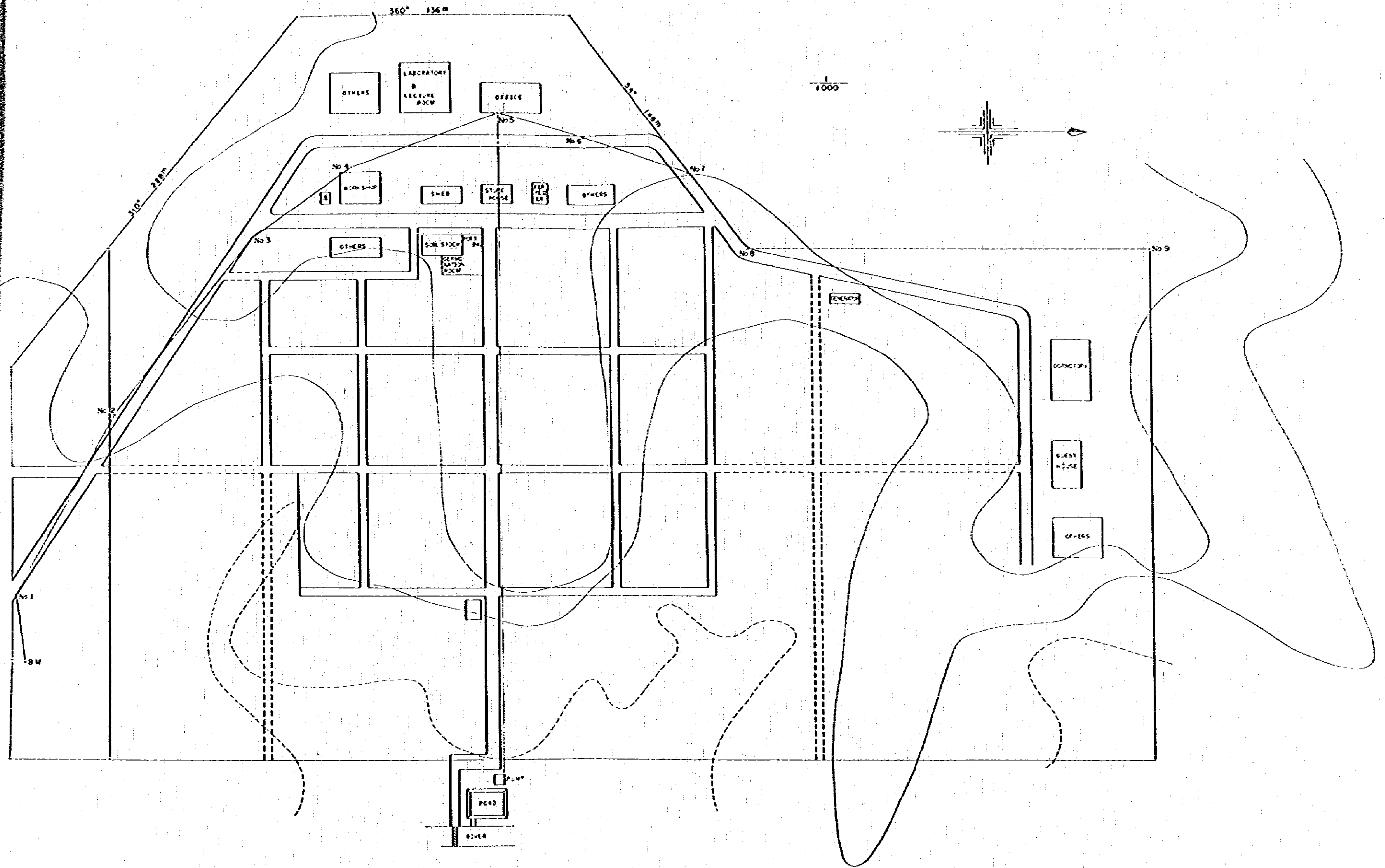
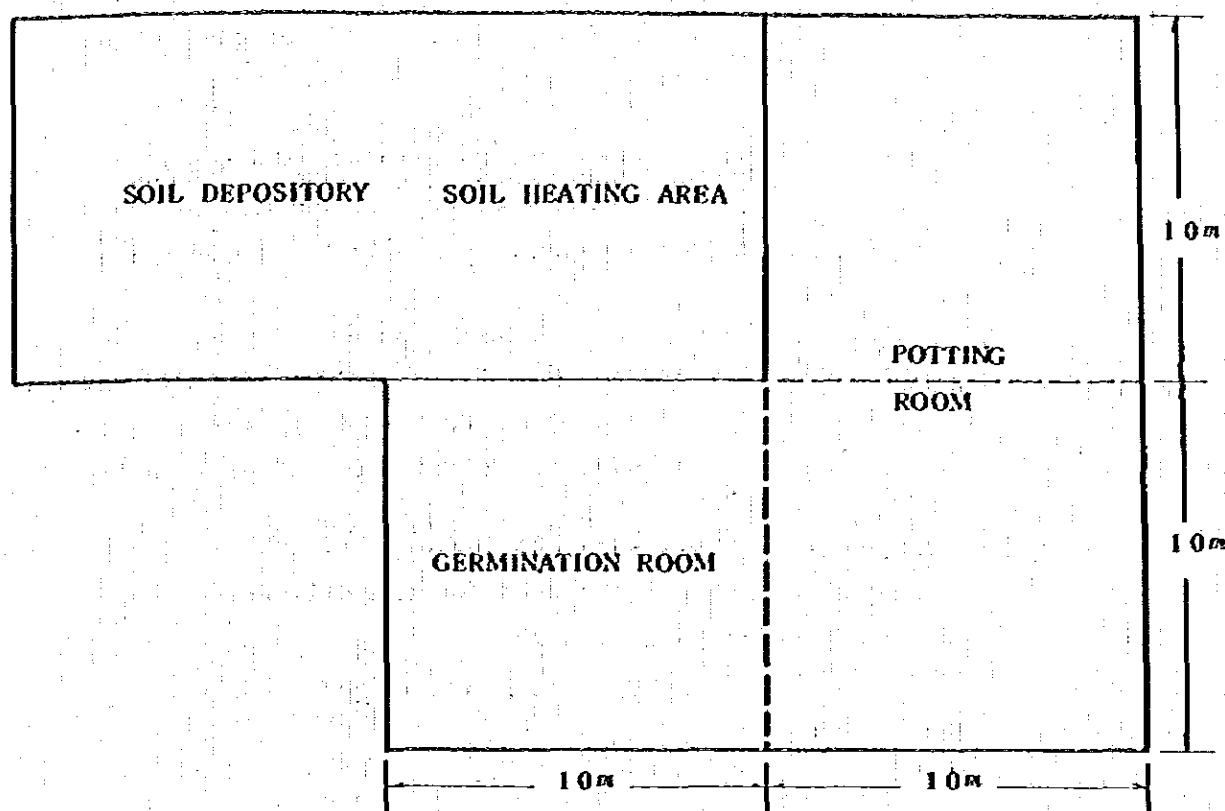


Fig. 3-3. WORKING SHED



River Baun with a ditch leading from the river. This reservoir will be used for irrigation of the nursery. During the rainy season, it can be expected that the whole area of the reservoir will be flooded, and there should be no problem in leading water from the river into the reservoir. However, it will be necessary to construct a small dam for the dry season when the water level of the River Baun goes down. Since it is expected that a large amount of mud will be accumulated in the reservoir soon after the rainy season, some measures would be required to get rid of the mud.

Further investigation and research are necessary for the dam construction and mud elimination facilities. (Refer to Fig. 3-4)

- 1-4 Watering facilities: For the purpose of watering of the nursery, three rows of sprinklers and one holding tank on each row will be set up. The capacity of each tank is 30,000 liters (30 tons). The tanks will be built in the nursery.

- 1-5 Holding tank: The capacity is 20,000 liters. It will be set up on the highest part of the nursery. This tank will be used in the case the sprinklers do not work, and the water from the tank will be used normally in the operation facilities.
- 1-6 Warehouse for tools and other materials: 108 sq. m. Tools and other materials necessary for nursery practice such as plastic bags to cover pots will be stored here. (Refer to Fig. 3-5)
- 1-7 Warehouse for machinery: 108 sq. m. Vehicles necessary for the silviculture and the nursery, such as trucks, tractors and other machinery, will be stored here. (Refer to Fig. 3-6)
- 1-8 Warehouse for fertilizer: 88 sq. m. Will be used for storage of the fertilizer used for the silviculture and nursery. (Refer to Fig. 3-7)

Fig 3 - 4 PLAN OF RESERVOIR

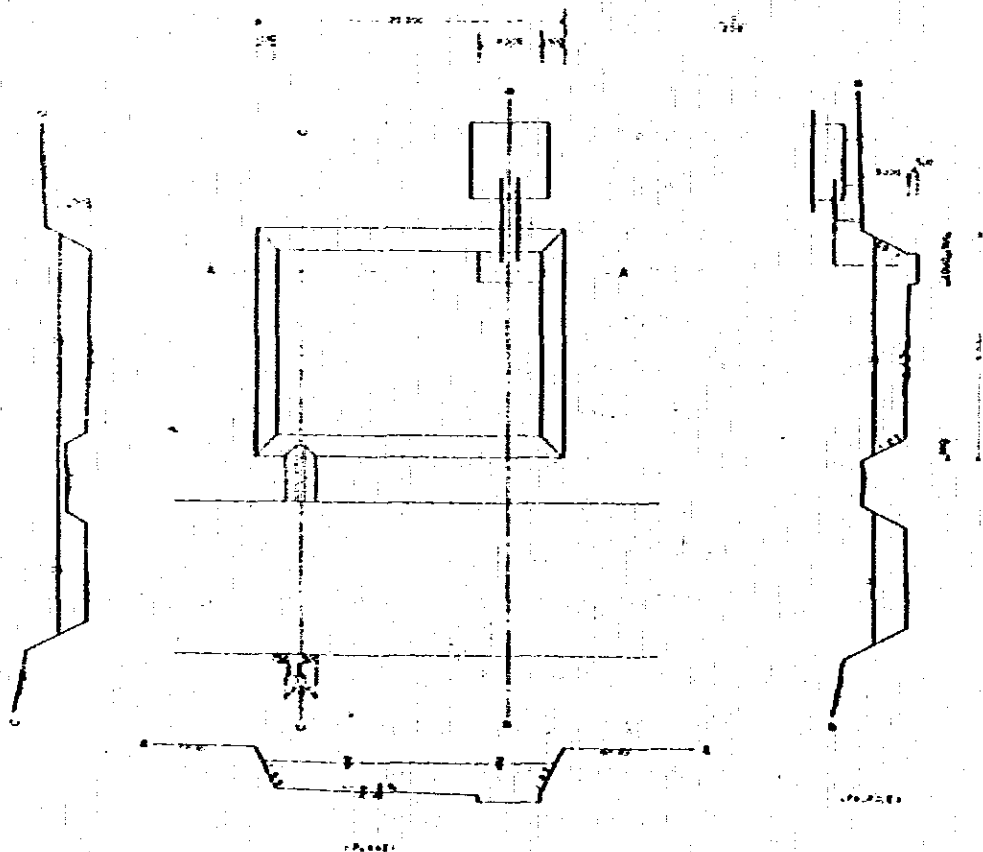


Fig 3 - 5 STORO HOUSE (9x12=108m²)

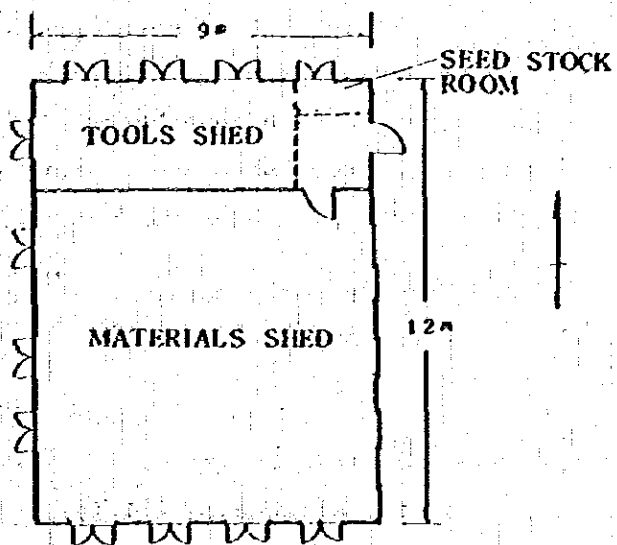


Fig 3 - 6 SHED (9x12=108m²)

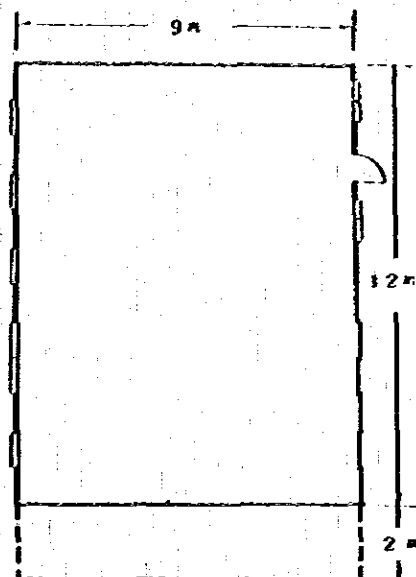
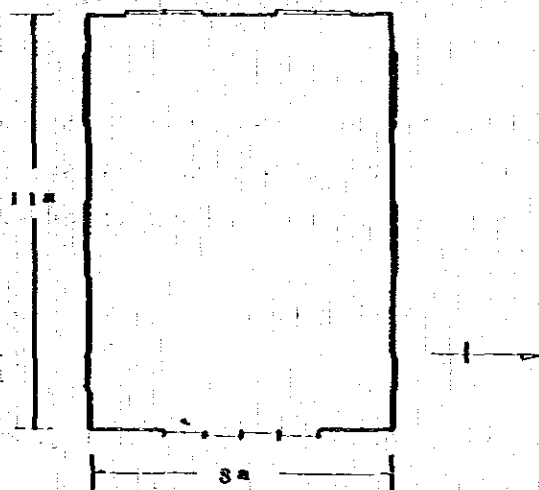


Fig 3 - 7 FERTILIZER STOCK HOUSE (8x11=88m²)



1-9 Oil storage: 25 sq. m. The gasoline for the vehicles and other fuels for machinery will be stored here.
(Refer to Fig. 3-8)

1-10 Repair shop: 224 sq. m. Fixing, sheet metal processing, and painting of the vehicles and other machinery to be used for the silviculture and nursery can be done here. A machine shop, a wood working shop, a tool shed and a store room of parts will be also built nearby. (Refer to Fig. 3-9)

1-11 Pump room: 12 sq. m. Pump is for pumping water from the reservoir into the tanks for the sprinklers and the holding tank. (Refer to Fig. 3-10)

1-12 Electric generator room and wiring: 12 sq. m. For storage of the electric generator for all the facilities and buildings. The wiring to each facility will be decided later when further investigation has been done. (Refer to Fig- 3-11)

2. Administration facilities

2-13 Administration office: 300 sq. m. To be used as a administrative office for the plantation and nursery work.
(Refer to Fig. 3-12)

2-14 Forestry laboratory and training rooms: 259 sq. m.
Testing and research work concerning with afforestation and nursery activities, and meteorological observations will be conducted here.
A lecture hall and training rooms will be also provided.
(Refer to Fig. 3-13)

2-15 Accomodation building for engineers: 257 sq. m.
These buildings will be used for experts.
(Refer to Fig. 1-14)

2-16 Accomodation building for guests: 231 sq. m. This building will be used for Japanese experts who stay in this nursery for a short period and also for guests. The building has two stories, and the bedrooms will be on the second floor. It contains 4 rooms and will accomodate 8 people. (Refer to Fig. 3-15)

Fig. 3-8. OIL STOCK ROOM

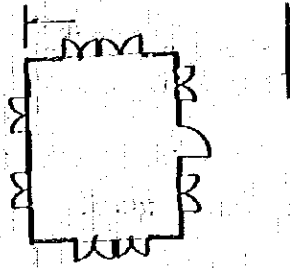


Fig. 3-9. WORK SHOP

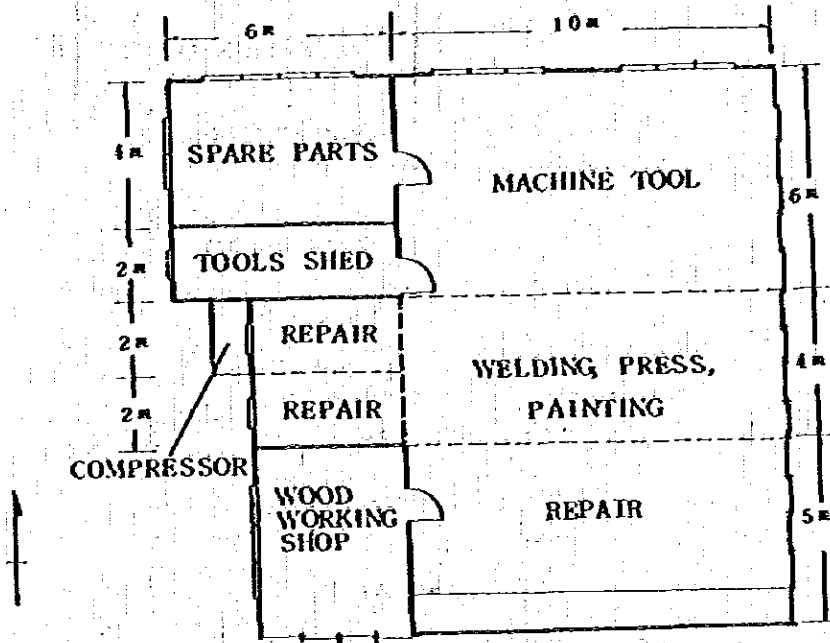


Fig. 3-10. PUMP HOUSE

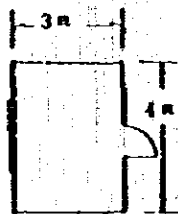


Fig. 3-11. GENERATOR HOUSE

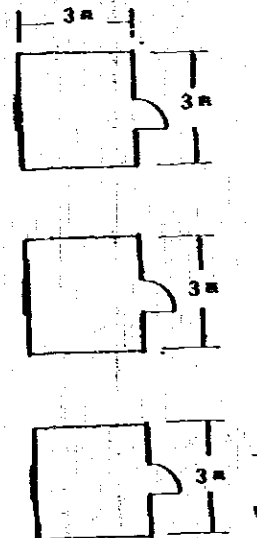


Fig. 3-12 Administration Office

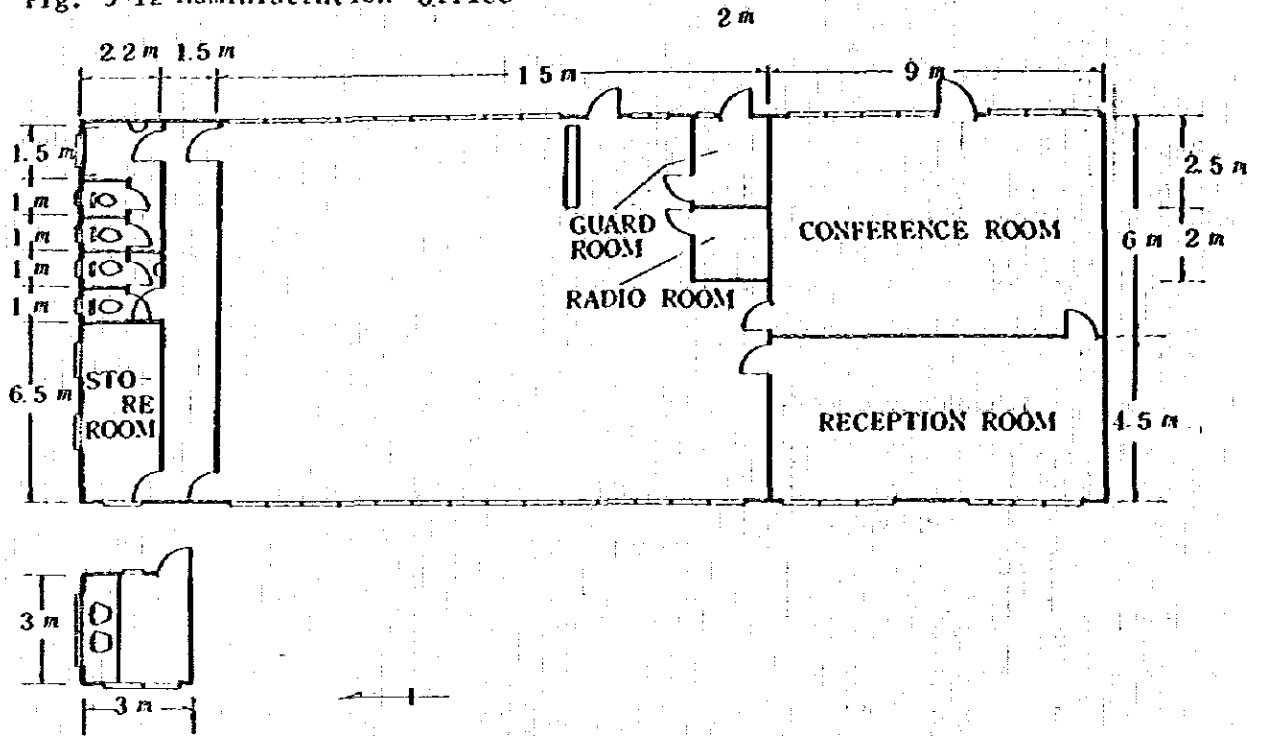


Fig. 3-13 Forestry laboratory and Room

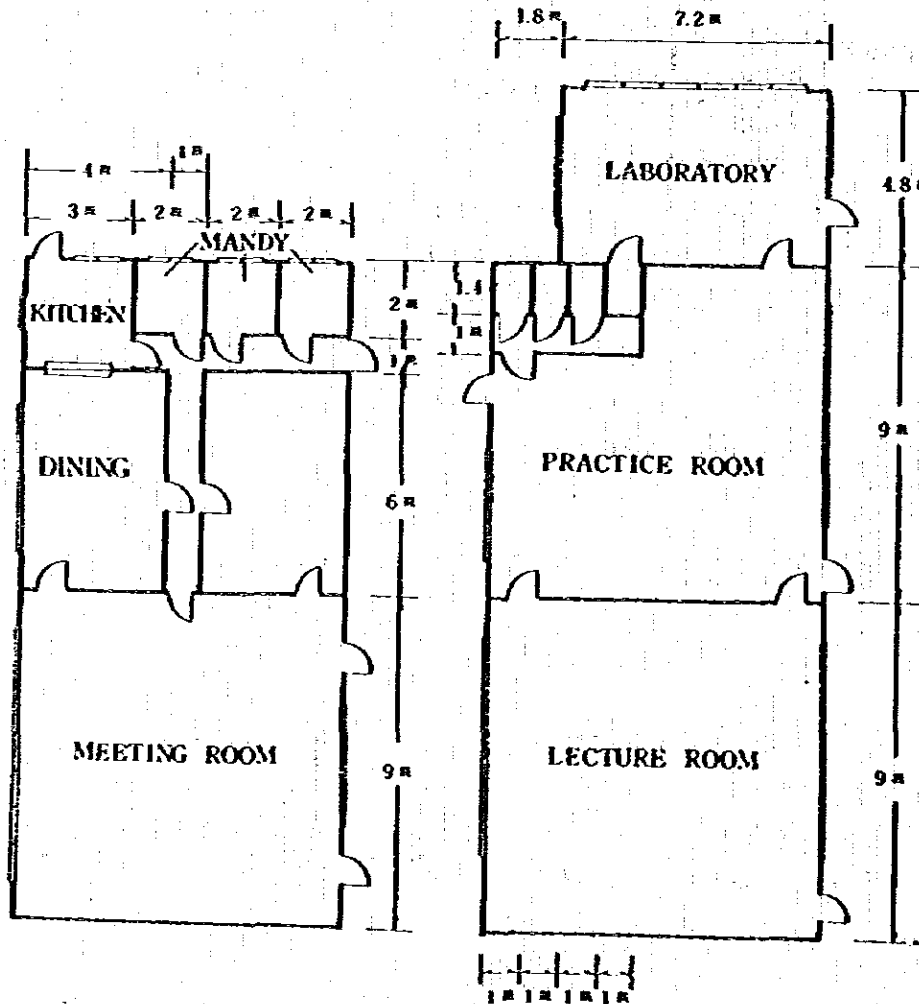


Fig. 3-14. DISPATCH ENGINEER HOUSE

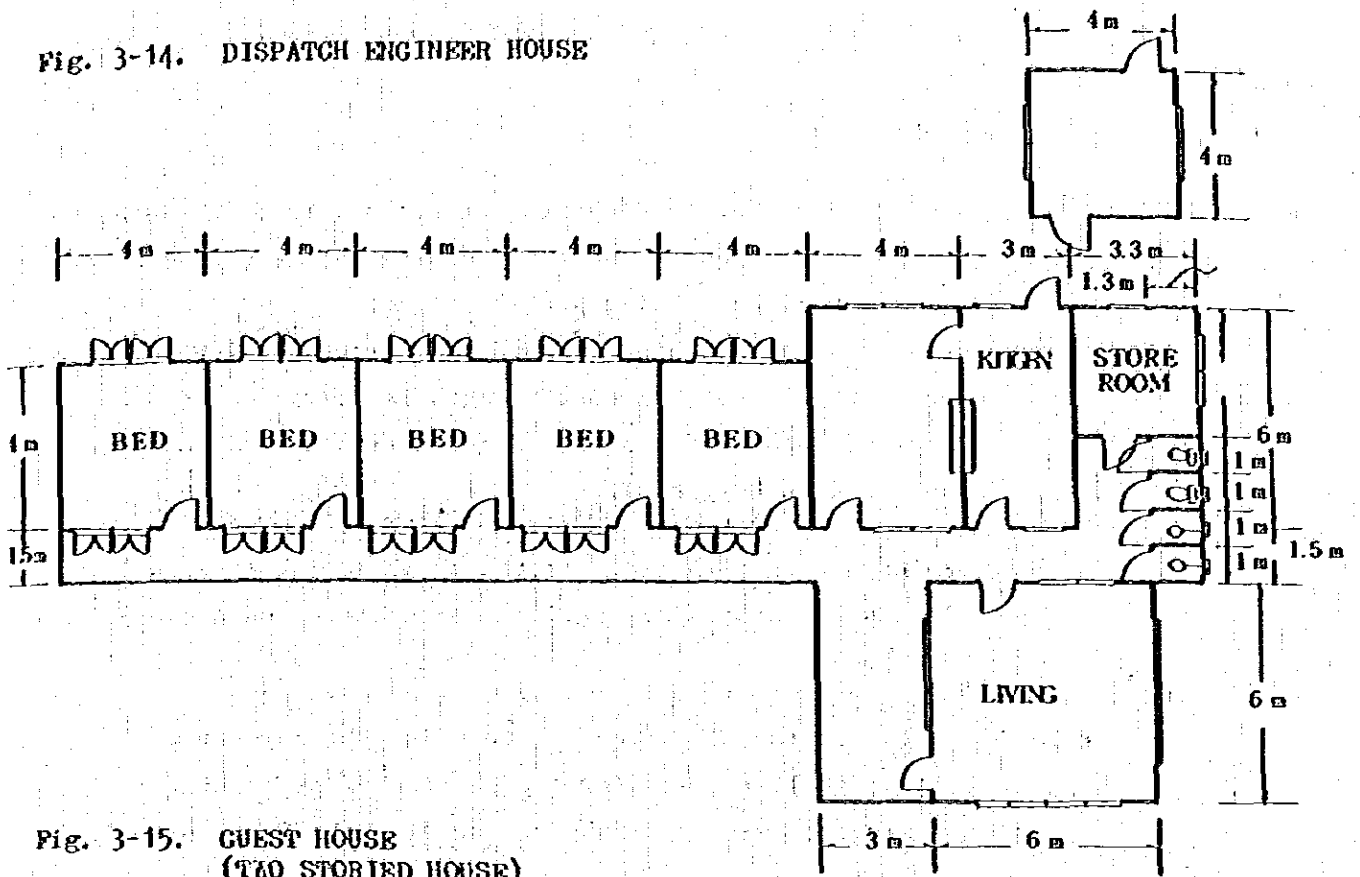


Fig. 3-15. GUEST HOUSE (TWO STORED HOUSE)

