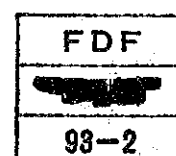


REPORT ON THE DETAILED DESIGN SURVEY
FOR THE DEVELOPMENT OF SUSTAINABLE
MANGROVE MANAGENT PROJECT
IN THE REPUBLIC OF INDONESIA

FEBRUARY, 1993

JAPAN INTERNATIONAL CORPORATION AGENCY



REPORT ON DETAILED DESIGN SURVEY
FOR THE DEVELOPMENT OF SUSTAINABLE MANGROVE
MANAGEMENT PROJECT
IN THE REPUBLIC OF INDONESIA

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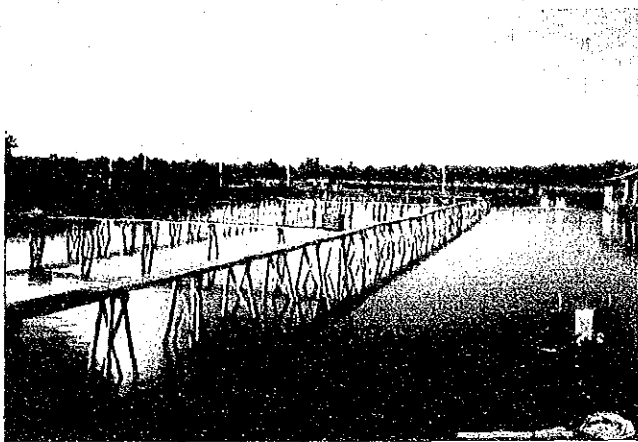
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National Forest land used as breeding pond of prawn.



A restored breeding pond.



Planned area for the construction of buildings and a nursery.



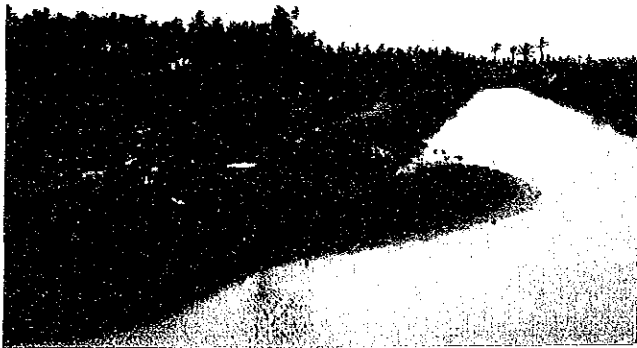
Entrance to forest road(public road at the right hand side).



A section of forest road to be improved.



Construction site of bridge.



Site for the establishment of a nursery and channel.



Plot for observation of natural forest and observation plank road(Block II at the left hand side and Block I at the right hand side).



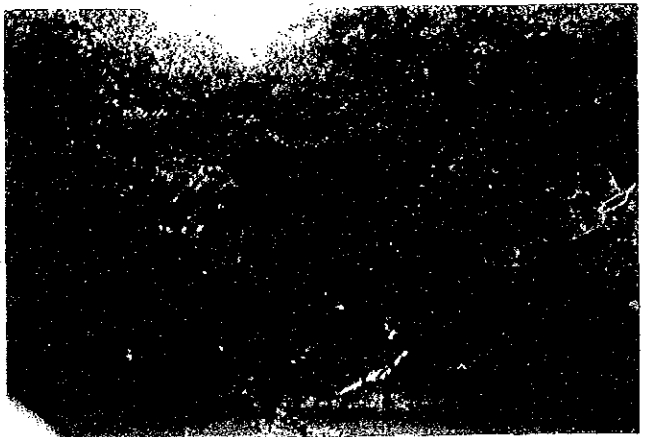
Plot for observation of natural forest in Block II (Rhizophora sp. has invaded the site where Sonneratia sp. grows).



Plot for observation of natural forest(Block III at the left hand side and Block II at the right hand side).



Gili Petangan(Lombok) area designated for plantation.



Location of observation plank road in demonstration forest of Block II.

1. OUTLINE OF THE PROJECT

1-1 Background and Details

Apart from timber production, mangrove forests have many functions including environmental conservation and enrichment of fisheries resources, etc. They are valuable forestry and environmental assets which are deeply involved in the life and industry of the people living in tropical areas.

In recent years, with the development of coastal areas due to such factors as population increase, the area of mangrove forest has been shrinking due to conversion to paddy fields, aquaculture ponds, salt pans, etc. and exploitation by the local people and others for fuel and building materials.

In these circumstances, the importance of management and conservation of the world's mangrove forest resources, the establishment of afforestation technology and sustainable management is being recognised.

Furthermore, in respect of the decline of mangrove forests in Indonesia, proper conservation and management of the development of mangrove forest resources is being demanded for the sake of timber production, coastline conservation and scenic conservation. Additionally, the urgent regeneration and restoration of mangrove forests has become important in devastated areas such as the cut over of mangroves forests and evacuated prawn farms in former aquaculture areas. These are the circumstances which have prompted the Japanese government to undertake feasibility study activities, details of which are set out below.

- January 1992 : A primary basic survey was conducted to investigate the feasibility of a project to gather basic data on mangrove forests.
- April 1992 : A secondary basic survey was conducted to summarise potential areas for the experimental study.
- June/July 1992 : A preliminary planning survey was conducted to discuss the basic structure of the Project, the administrative system for the Project, measures to be taken by both countries, a planned Record of Discussion (R/D) and a planned Tentative Schedule of Implementation (TSI).
- October/November 1992 : A survey was conducted for preliminary planning (R/D) to discuss and sign the R/D and TSI. The R/D was concluded on 4 November 1992.

1-2 Dispatch of Survey Team

In accordance with the R/D which was concluded on 4 November 1992, detailed designs were drawn up for specific buildings, forest roads, nurseries, project sites (for trial plantation areas and the establishment of experimental sections of natural forest), etc., and a survey team was dispatched to gather information on activities related to on-site operations and to hand them over for the supervision of operations.

1) Period of Assignment

21 December 1992 to 3 February 1993 (45 days)

2) Composition of Survey Team

Name	Responsibility	Organization
Tadao Ohara	Team leader/project site design	Japan Forestry Technololgy Association
Yoshimi Imai	Forest roads	ditto
Fumio Asaka	Nursery and facilities	ditto

3) Survey Program

Survey program is as shown in Table 1

Day	Date	Details
1	12/21 (M)	Move from Tokyo to Jakarta
2	12/22 (T)	Courtesy call at Japanese Embassy & Ministry of Forestry, meeting at JICA
3	12/23 (W)	Move Jakarta to Denpasar
4	12/24 (T)	Courtesy call at Consular Office, meeting with project team
5	12/25 (F)	Explanation of proposed project sites to project team
6	12/26 (S)	Survey of forest roads
7	12/27 (S)	
8	12/28 (M)	Courtesy call at Kanwil Bali, explanation of the work, courtesy call at Dinas Kehutanan
9	12/29 (T)	Survey of forest roads
10	12/30 (W)	and
11	12/31 (T)	Meeting at Balai RLKT No. 7 with counterparts
12	1/ 1 (F)	
13	1/ 2 (S)	
14	1/ 3 (S)	
15	1/ 4 (M)	
16	1/ 5 (T)	Move from Denpasar to Mataram, courtesy call at Kanwil NTB, meeting at Sub-Balai RLKT No. 7
17	1/ 6 (W)	Determination of project site at Lombok

- 18 1/ 7 (T) and
- 19 1/ 8 (F) Explanation to Sub-Balai RLKT No. 7
- 20 1/ 9 (S)
- 21 1/10 (S) Move from Mataram to Denpasar
- 22 1/11 (M) Discussion with the project team concerning
total planning, meeting relative to operation
planning of each field
- 23 1/12 (T) and
- 24 1/13 (W) Topographic survey of projected nursery,
determination on-site of observation footpath
route
- 25 1/14 (T)
- 26 1/15 (F)
- 27 1/16 (S)
- 28 1/17 (S)
- 29 1/18 (M) Survey with Kanwil Bali, Dinas Kehutanan, c/p,
experts for confirmation of the Project sites
- 30 1/19 (T) Data collection for calculating construction
costs related to operations
- 31 1/20 (W) and
- 32 1/21 (T) Preparation of charts, etc.
- 33 1/22 (F)
- 34 1/23 (S)
- 35 1/24 (S) Move (Team Member Asaka) Denpasar to Jakarta,
preparation of list of transferred materials
and related data investigation
- 36 1/25 (M) Explanation of plan summary to Balai RLKT No.7
- 37 1/26 (T) Explanation of plan summary to Kanwil Dinas
Kehutanan, meeting with project team
- 38 1/27 (W) Move from Denpasar to Jakarta
- 39 1/28 (T) Report on on-site survey at JICA office
- 40 1/29 (F) Estimation of construction costs, arrangement
of transferred materials, data collection
- 41 1/30 (S)
- 42 1/31 (S)

- 43 2/ 1 (M) Report to Director of Afforestation, Ministry of Forestry, explanation of survey details to JICA Office Director, collection of information related to work execution
- 44 2/ 2 (T) Move from Jakarta
- 45 2/ 3 (W) to Tokyo

1-3 Principal Interviewees

(1) Japanese Embassy in Indonesia

Seto Nobuhisa, First Secretary
Minoru Ishida, Consul Resident officer in Denpasar

(2) JICA Indonesia Office

Akira Takahashi, Director
Kenichi Shishido, Staff

(5) Ministry of Forestry

Purwadi Mangunwardojo, (Chief of Division of Reforestation and Regreening, Directorate General of Reforestation)
Asep Suwarna, Staff of Foreign Technical Cooperation Section
Yudi Sutrisno, ditto

(6) Ministry of Forestry, Kanwil Bali

Effendy A. Sumardja, Kepala Kantor Wilayah
MGS Rimbawan, Kepala Seksi Reboisasi

(7) Land Rehabilitation and Soil Conservation Centre
Region VII (BALAI RLKT No. 7)

Nasori S. Djajalaksana, Kepala Balai RLKT No. 7 (Centre Chief)

Esti Wening Sarawati, Nurseries C/P

Abdul Razan, Afforestation C/P

Sub-Balai RLKT No. 7 Bali

Yusuf Kamar, Chief of Monitoring and Evaluation Section

Suquiarto, Chief of Technical Planning Section

Sub-Balai RLKT No. 7 NTB

Suhardi S. W., Kepala Sub-Balai RLKT NTB

(9) Dinas Kehutanan Bali

Ir. Gede Nyoman Wiranatha, Kap. Subdiv. Bina Hutan

Ir. Ketut Subawa, Kap. Seksi Perlindungan

I. Ny Putra Aonyana, Staf RPH Prapat Benoa

(11) KANWIL N.T.B.

Hery Subagjo

(3) Project Experts

Shoshi Tanaka, Team Leader

Seishi Miura, Nursery

Shuichiro Namada, Silviculture

Shinji Hayashi, Ecosystem

Ryuichi Terui, Forest Management

Hideki Hachinohe, Liaison Officer

2. PROJECT IMPLEMENTATION PLAN

2-1 Objectives of the Project

The Project will be carried out in Bali and Lombok Islands, Indonesia, for the purpose of collecting useful data, establishing technology to recover mangrove forests, and setting up of technical and managerial methods for the Sustainable Mangrove Management System in the recovered areas, which will contribute to the promotion of re-forestation and the sustainable development of the forests in the tropics, by the surrounding communities and the private sector.

2-2 Activities of the Project

To attain the above-mentioned objectives, the following cooperation activities will be implemented:

- (1) Selection of tree species for mangrove plantations
- (2) Development of silviculture technique
- (3) Cost estimation for mangrove plantation
- (4) Study on effects of mangrove forest on surrounding environment
- (5) Study on conservation management of flora and fauna in the mangrove ecosystem in the Project sites
- (6) Pests and disease control techniques
- (7) Study on the social and economic benefits for forestry and fisheries in the mangrove forests and surrounding

areas

- (8) Preparation of a mangrove forest management model
- (9) Development of utilisation techniques for mangrove forest products
- (10) Other activities:
 - (a) construction of roads;
 - (b) establishment of nursery; and
 - (c) construction of office, storehouse and others

2-3 Basic Implementation Plan

The project items set out in Section 2-2 which are to be performed in this experimental study activities shall be carried out through a trial plantation and an observation survey of a natural forest. In addition, the facilities which are necessary for this shall be constructed.

1) Trial plantation

The trial plantation which is to be undertaken by this Project aims to examine whether the creation of an industrial plantation would be feasible or not. However, in Indonesia at present, coastal forests including mangrove forests are regulated by Presidential Ordinance No. 32 of 1990, "Management of Protected Lands", as a protected forests.

Also, when creating an industrial plantation, it will be necessary to control the influence of waves and sand movement with a mangrove forest which acts as a green belt to protect the production forest.

The species of trees which make up a mangrove forest have large seeds which are moved only by the flow of the tides, so it can be said that crossings does not occur between wide regions. It will be necessary to consider each Indonesian province as a source area for seeds, to display the tree species which constitute mangrove forests, and also to test seeds of each source area separately for their suitability to the project site.

From the above, it follows that trial plantations will be of three types:

- (1) Trial Plantation A - planted as a production forest,
- (2) Trial Plantation B - planted as a conservation forest,
- (3) Trial Plantation C - planted as a demonstration forest.

(Planning details are discussed in Section 2-5 Trial Plantation Plan.)

The above trial plantations shall be carried out over four years from the first year of the project (1993) to the fourth year (1996) in areas totalling 200 ha, 150 ha in Bali and 50 ha in Lombok. Supplementary planting will be done only in the fifth year (1997). The areas to be planted each years are as follows:

1st year (1993)	30 ha (Bali 30 ha)
2nd year (1994)	60 ha (Bali 50 ha, Lombok 10 ha)
3rd year (1995)	60 ha (Bali 40 ha, Lombok 20 ha)
4th year (1996)	50 ha (Bali 30 ha, Lombok 20 ha)
5th year (1997)	supplementary planting only
Total	200 ha (Bali 150 ha, Lombok 50 ha)

2) Natural forest observation survey

A long time will be required to regenerate and restore mangrove forests by planting and it will be extremely difficult to obtain sufficient data during the period of this project. The basic data necessary in order to create production forests and establish a sustainable management system shall be complemented by conducting observation surveys of natural forests. Natural forest experimental observation areas shall be 50 ha in Bali and 50 ha in Lombok.

3) Construction of related facilities

In order to implement this experimental study, the following related facilities shall be constructed:

- (1) Centre : A group of buildings such as Project Office, laboratory, work sheds, etc.
- (2) Nursery : For producing seedlings for trial plantations
- (3) Forest roads : Access road from the public road past the Nursery to the Centre and part of the working road
- (4) Observation footpaths : Wooden footpaths for observation surveys of the natural forest

Project areas in Bali and Lombok shall be as follows:

Table 1 Project Areas

(Unit : ha)

Location Item	Bali	Lombok			Total
	Benao Perapat	Gili Sulat	Gili Petangan	Teluk Waru	
Trial plantation	150		50		200
Natural forest observation site	50	50			100
Centre	0.7				0.7
Nursery	0.8			0.5	1.3
Total	201.5	50	50	0.5	302

2-4 Project Sites

Project sites are the Benoa Prapat national forestland in Benoa Bay in the south of Bali Island and Gili Lawang Sulat Petangan national forestland in the northeast of Lombok Island. (See Fig. 1 Location map)

1) Bali

Benoa Prapat national forestland is located about 10 km south of the Province capital, Denpasar. Its northern side is an extremely broad shallow inlet with gentle waves formed from an alluvial plain produced by rivers and streams flowing from the mountain range which forms the spine of the

island of Bali and an island joined to the shore (Bukit Batu) on the other side. At one time, there was a coastal mangrove forest which flourished here on a large scale but the tidal belt is now used as a prawn cultivation pond (Tambak). Consequently, the mangroves remain as a belt along the coastline.

Benoa Prapat national forestland is 492 ha, of which 334 ha is occupied by the Tambak (Tambak 282 ha, canals 21 ha, other 31 ha) and the natural mangrove forest is 158 ha. (See Fig. 2)

(1) Centre and Nursery

About 6 ha of the 31 ha of "other" land in the national forestland is flat land which is grassed at present and it is here that the Centre and Nursery will be established.

(2) Trial plantation site

In the three years, 1990, 1991 and 1992, the whole of the Tambak in the national forest has been returned to the Ministry of Forestry and plantings to restore the mangrove forest have been conducted there in 1990/91 and 1991/92.

In July 1992, a survey of the planted area showed a survival rate of less than 30% over most of the Tambak and in August 1992, since the budget for planting in respect of the area resumed in 1992 had been determined prior to the signing of the R/D for the Project (the R/D was signed on 4 November 1992), the Bali Provincial Forestry Service (Dinas Kehutanan), which is responsible for project operations, carried out the planting.

With this as a basis, the trial plantation sites have

been determined in consultation with the Director of Reforestation and Regreening, Ministry of Forestry, the Chief of Regional Forestry Office, Bali, the Chief of Land Rehabilitation and Soil Conservation Centre No. 7, the Chief of Forest Protection Section of Provincial Forestry Service and Project experts.

a : The national forests are divided into blocks I to V of which Block II shall be a site for the project operations. Land resumed in 1992 shall be the site of the trial plantation to be performed within this Project in 1993.

b : As for the remaining blocks I, III, IV and V, the Regional Forestry Office shall carry out planting in respect of the 1992 resumed land.

c : In respect of blocks I to V, a survey to appraise areas already planted in 1990/91 and 1991/92 shall be carried out by the Bali Forestry Office, Land Rehabilitation and Soil Conservation Centre No. 7, Provincial Forestry Office and the project members, (the appraisal survey to be based on the results of the July 1992 survey) and they shall demarcate sites for trial plantations after 1994.

d : A trial plantation on sand deposits shall be made on the sand deposits on the seaward side of the natural forest in Block V.

(3) Experimental site for observation of natural forests

The site for observing natural forests shall be 50 ha of the natural forest which spreads out on the seaward side of the Tambak. The natural forest observation site shall be divided into blocks I and II.

2) Lombok

The Gili Lawang, Sulat and Petangan national forests off-shore from Sambelia in the Lombok Timur District in the northeast of Lombok Island are protected forests (Hutan Lindung). Of these, Gili Sulat and Gili Petangan will be project sites. (See Fig. 3)

(1) Trial plantation site

Mangroves had once been established around Gili Petangan but they were exploited for fuel for the production of lime from coral so that now nothing can be seen but stumps and aerial roots. This cleared area is a natural landform and shall be used for the trial planting of a production forest. The area of the plantation shall be 50 ha.

(2) Experimental site for natural forest observation

Gili Sulat is a natural mangrove forest which covers the whole island, comprised of species such as Rhizophora spp., Bruguiera sp., Sonneratia sp., etc., growing vigorously, some of them more than ten metres high. Some 50 ha of this natural forest shall become an experimental observation forest and a seed collecting forest, in which wooden foot-paths for observation shall be established.

(3) Nursery

Seedlings for the Gili Petangan trial plantation will be grown at Lombok. Considering the management and supervision during nursing, model mangrove plantation area performed by the NTB Provincial Forestry Service and its surroundings near Teluk Waru, about 20 km south from Mataram, the capital of Lombok will be used as nursery so no nursery facilities will be built.

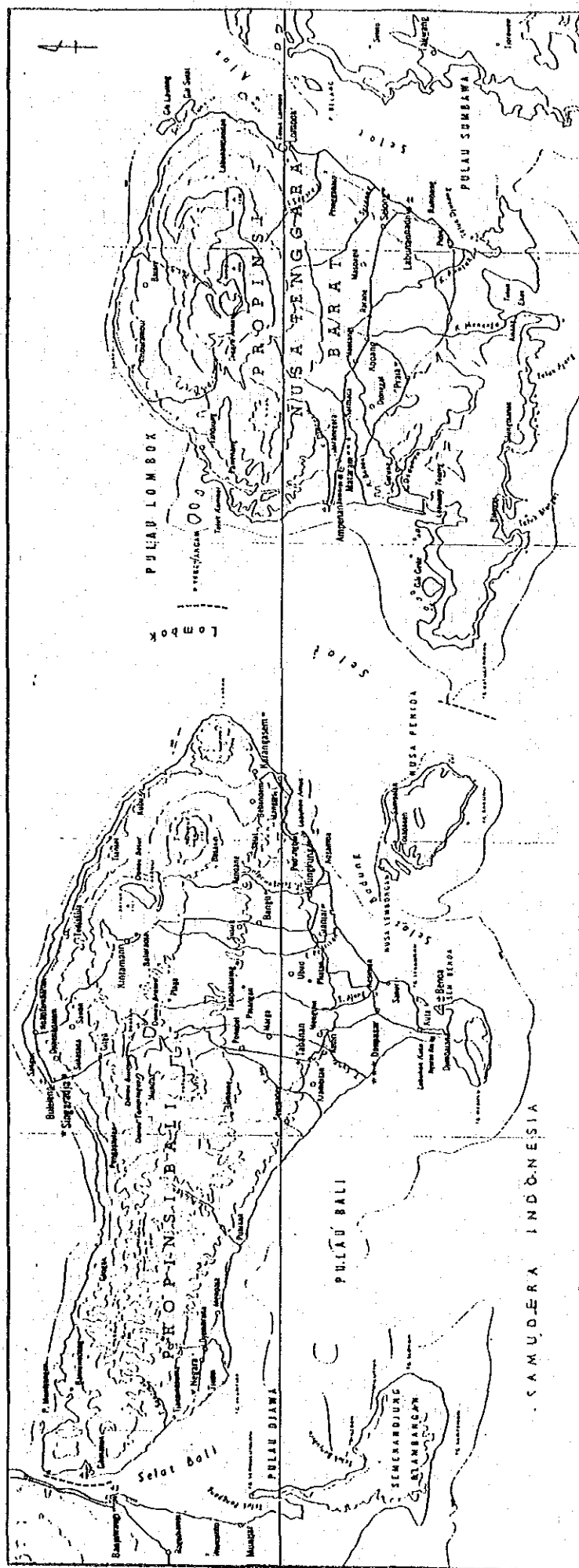


Fig. - 1 Location of BALI and LOMBOK
(1 : 1,020,000)

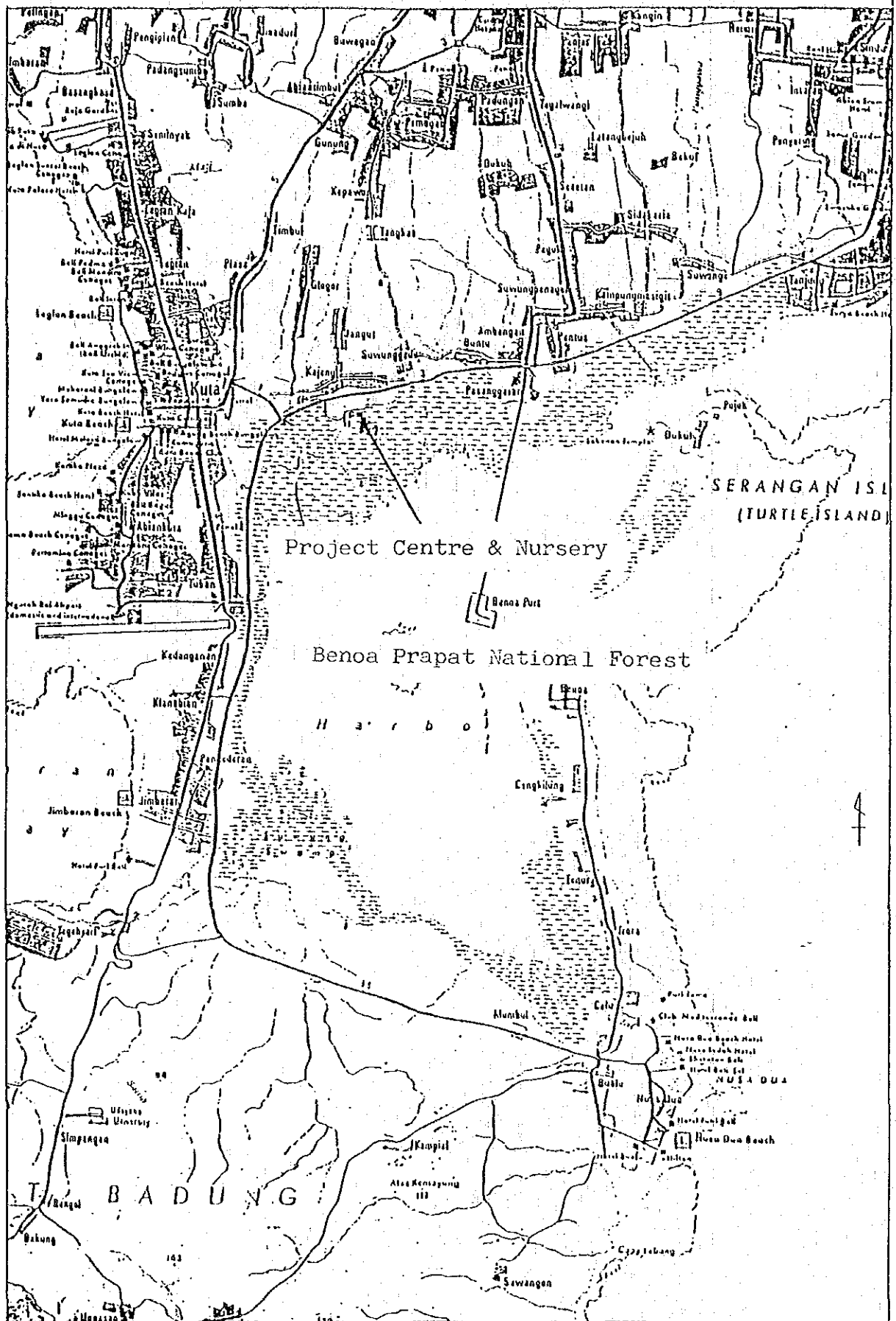


Fig. - 2 Project Site in Bali (1: 79,170)

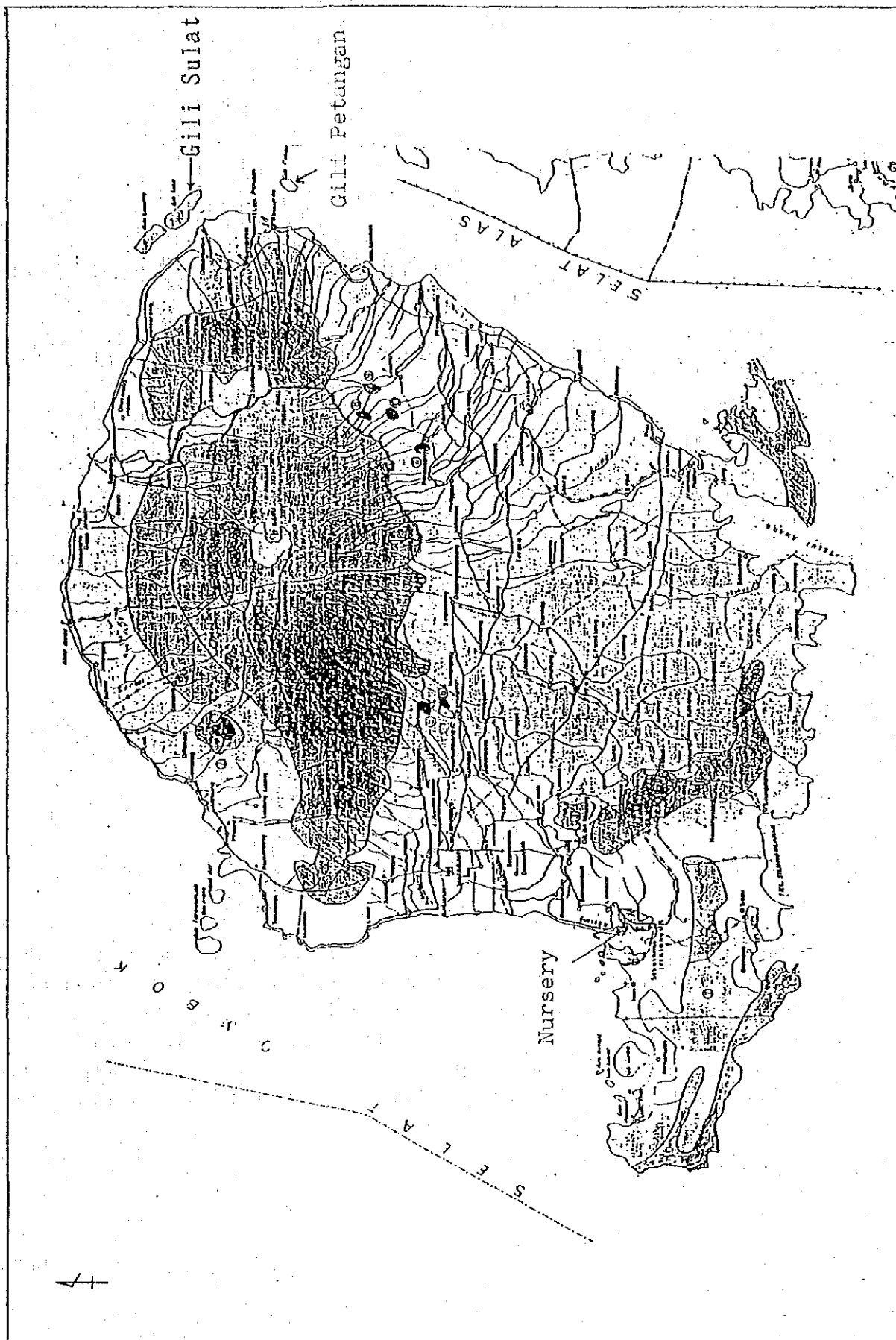


Fig. - 3 Project Site in Lombok (1: 576,000)

2-5 Trial Plantation Plan

1) Summary of Plan

Trial Plantation A, Trial Plantation B and Trial Plantation C will be carried out, details of which are as follows:

(1) Trial Plantation A (called the Production Forest)

a : Production Forest I (Bali) and Production Forest III (Lombok)

The purpose of these is to establish plantation technology for the regeneration and restoration of mangrove forests as production forests and to carry out the establishment of sustainable management technology and management methods for the regenerated mangrove forests.

The areas of the plantations will be 90 ha in Bali and 50 ha in Lombok.

b : Production Forest II (Bali)

The purpose of this is for silviculture using experimentally grown seedlings and to make a plantation using different methods of cultivation.

The area of the plantation will be 15 ha in Bali only.

(2) Trial Plantation B (called the Conservation Forest)

The purpose of this is to establish plantation technology in order to regenerate and restore a mangrove forest as a conservation forest and for effective conservation such as regreening and prevention of coastal erosion as well as to investigate its effect on the surrounding environment.

The area of the plantation will be 25 ha in Bali only (including a plantation of 2-3 ha in the sand deposit area).

(3) Trial Plantation C (called the Demonstration Forest)

The purpose of this is to introduce tree species from mangrove forests of each Indonesian province, investigate their suitability by production areas and achieve the effect of displaying regenerated and restored mangrove forests.

The area of the plantation will be 20 ha in Bali only.

As noted above, Trial Plantation A is a production forest, Trial Plantation B is a conservation forest and Trial Plantation C is a demonstration forest, and their purposes are different.

For this reason, with respect to items such as tree species, planting densities, seed sources, seedlings, etc., the trial planting shall be in accordance with Trial Plantation Criteria and surveys of striking, growth, etc. shall be carried out continuously and accurate data shall be collected and collated.

2) Trial Plantation Criteria

The criteria for trial plantation shall be as follows:
(See Table 2)

(1) Tree Species

In respect of tree species to be used in trial plantations for this project, consideration will be given to the following:

- a: species which occur frequently in Indonesia
- b: species whose seeds are easily obtained
- c: species which are economically useful
- d: species which are easily regenerated
- e: species which benefit the lives of the local inhabitants
- f: species with broad capacity to adapt to the environment

Table-2

Criteria of trial plantation

Site		Bali							Lombok				
Species		Sonneratia sp.	Bruguiera gymnorhiza	Rhizophora apiculata	Rhizophora mucronata	Avicennia sp.	Ceriops tagal	Xylocarpus granatum	Sonneratia sp.	Bruguiera gymnorhiza	Rhizophora apiculata	Rhizophora mucronata	Avicennia sp.
Trial Plantation	Trial Plantation A												
	Production Forest I	○	○	○	○	○							
	Production Forest II	○	○	○	○	○							
	Production Forest III								○	○	○	○	○
Trial Plantation B	Conservation Forest	○	○	○	○	○							
	Demonstration Forest	○	○	○	○	○	○	○					
Trial Plantation C	1 m × 1 m (10000 tree/ha)	○	○	○	○	○				○	○	○	
	1 m × 2 m (5000 tree/ha)	○	○	○	○	○			○	○	○	○	○
	2 m × 2 m (2500 tree/ha)	○	○	○	○	○	○	○	○	○	○	○	○
	2 m × 3 m (1666 tree/ha)	○	○	○	○	○							
Stock type	Potted seedling	○	○	○	○	○	○	○	○	○	○	○	○
	Bare rooted seedling	○	○	○	○	○							
	Direct planting		○	○	○					○	○	○	
	Direct seeding	○				○							
Seed Provenance	Bali - Lombok - Jave Timur	Trial Plantation A, B & C											
	Jave Tengah	Trial Plantation A & C											
	Jave Barat, Riau, Sulawesi, Selatan	Trial Plantation A & C											
	Sumatera, Kalimantan, Maluku, Irian and NIT	Trial Plantation C											

The five main species to be used shall be:

- Sonneratia sp.
- Bruguiera gymnorhiza
- Rhizophora apiculata
- Rhizophora mucronata
- Avicennia sp.

In Trial Plantation C, the Demonstration Forest, two species, Ceriops tagal and Xylocarpus granatum, shall be added to the five species mentioned above, making a total of seven species.

b. Planting Densities

In order to understand the effect of planting density on the growth and quality of standing tree and the density which is appropriate to the use of the timber after the forest is grown (in particular, its relation to charcoal yield) and to grasp the influence of different planting densities on forest growth, the standard density shall be 2500 trees per hectare (2 m x 2 m) and trial plantations A, B and C shall be as follows:

Trial Plantation A (Production Forest)

Production Forests I and III	10,000 trees/ha (1 m x 1 m)
	5,000 trees/ha (1 m x 2 m)
	2,500 trees/ha (2 m x 2 m)
Production Forest II	2,500 trees/ha (2 m x 2 m)

Trial Plantation B (Conservation Forest)

	2,500 trees/ha (2 m x 2 m)
	1,666 trees/ha (2 m x 3 m)

Trial Plantation C (Demonstration Forest)

2,500 trees/ha (2 m x 2 m)

c. Seed provenance

Seeds for both trial plantations A and B will be obtained from the project sites and their surroundings and from Java Timur. (This seed provenance from Bali, Lombok and Java Timur will be one class.

With respect to Trial Plantation A, in consideration of its use for future production, the seeds from superior trees shall be introduced. For this purpose, in addition to the above-mentioned seed production area, the seeds will be obtained from Java Tengah and one of Java Barat, Riau and Selawesi Selatan, totally from 3 provenances.

With respect to Trial Plantation C, seeds will be obtained from each Indonesian province.

d. Planting Methods, etc.

Seedlings shall be potted as a matter of principle. In accordance with the experimental item, the planting method shall be with bare rooted seedlings or direct cutting or direct seeding to the plantation site. Bruguiera gymnorhiza, Rhizophora apiculata and Rhizophora mucronata shall be directly cut and Sonneratia sp. and Avicennia sp. shall be directly seeded.

3) Establishment of Trial Plantation Divisions

Trial plantation divisions based on the planning summary shall be as follows.

(1) Production Forest I (Bali)

- (a) Place : former Tambak site
- (b) Plantation area : 90 ha
- (c) Tree species : 5 main species
- (d) Seed provenance : Bali - Lombok - Java Timur, Java Tengah and one of Java Barat, Riau, Selawesi Selatan - a total of three
- (e) Planting density : 1 m x 1 m (10,000 trees/ha),
1 m x 2 m (5,000 trees/ha),
2 m x 2 m (2,500 trees/ha)
- (f) Seedlings : potted seedlings

(2) Production Forest II (Bali)

- (a) Place : former Tambak site
- (b) Plantation area : 15 ha
- (c) Tree species : 5 main species
- (d) Seed provenance : Bali - Lombok - Java Timur
- (e) Planting density : 2 m x 2 m (2,500 trees/ha)
- (f) Planting method : potted seedlings from experimental seedling cultivation and bare rooted seedlings, etc.

(3) Production Forest III (Lombok)

- (a) Place : Gili Petangan cleared former mangrove site
- (b) Plantation area : 50 ha
- (c) Tree species : 5 main species
- (d) Seed provenance : Bali - Lombok - Java Timur
- (e) Planting density : 1 m x 1 m (10,000 trees/ha),
1 m x 2 m (5,000 trees/ha),
2 m x 2 m (2,500 trees/ha)
- (f) Seedlings : potted seedlings and direct cutting

(4) Conservation Forest (Bali)

- (a) Place : former Tambak site
- (b) Plantation area : 25 ha
- (c) Tree species : 5 main species
- (d) Seed provenance : Bali - Lombok - Java Timur
- (e) Planting density : 2 m x 2 m (2,500 trees/ha),
2 m x 3 m (1,666 trees/ha)
- (f) Seedlings : potted seedlings
- (g) Other : Test planting shall be trialed in the sand deposits on the seaward side of the natural forest. The four tree species to be used shall be the five main species less Bruquiera gymnorhiza. The planting density shall be 2 m x 2 m (2,500 trees/ha) and, because of the open sea, the seedlings shall be big-sized, one year old seedlings.

(5) Demonstration Forest (Bali)

- (a) Place : former Tambak site
- (b) Plantation area : 20 ha
- (c) Tree species : 5 main species and Cerriops and Xylocarpus, a total of seven species
- (d) Seed provenance : as many as possible of the Indonesian provinces
- (e) Planting density : 2 m x 2 m (2,500 trees/ha)
- (f) Seedlings : potted seedlings

These trial planting blocks shall be established in the project sites of Bali and Lombok in the following way.

The trial plantation sites in the Benoa Prapat national forest and in Bali shall be divided into Blocks I, II, III, IV and V as follows:

(a) The facility areas such as the Project Centre, Nursery, etc. shall be placed in Block II. Also, it is planned to plant 30 ha in 1993. These will become Production Forest I, Conservation Forest and Demonstration Forest in Block II.

(b) Nursing experiment and planting method experiment will be conducted in Production Forest II but, in order to compare with Production Forest I, Production Forest II shall be located adjacent to Production Forest I.

(c) In order to enhance its effect of protecting a mangrove forest, the Conservation Forest shall be located in the former Tambak where the natural forest, which forms a green belt in Blocks I to V, is deteriorating.

The result of this distribution is shown in Table 3 and Fig. 4

Table 3 Plantation Area by Block

Unit: ha

Block No.	Trial Plantations				Total
	Production Forest I	Production Forest II	Conservation Forest	Demonstration Forest	
I	10	5			15
II	10		15	20	45
III	45	5			50
IV	10		10		20
V	15	5			20
Total	90	15	25	20	150

Lombok has only Production Forest III which is located in Gili Petangan as shown in Fig. 5

4) Planned planting in each year

In accordance with the Trial Plantation Criteria, the planting plans for each year in the Production Forests (I, II and III), Conservation Forests and Demonstration Forest shall be as follows:

(a) Production Forest I (Bali)

The five main tree species shall be planted. Planting will be repeated 4 times each species on each experimental plot by three planting densities and 3 seed provenances.

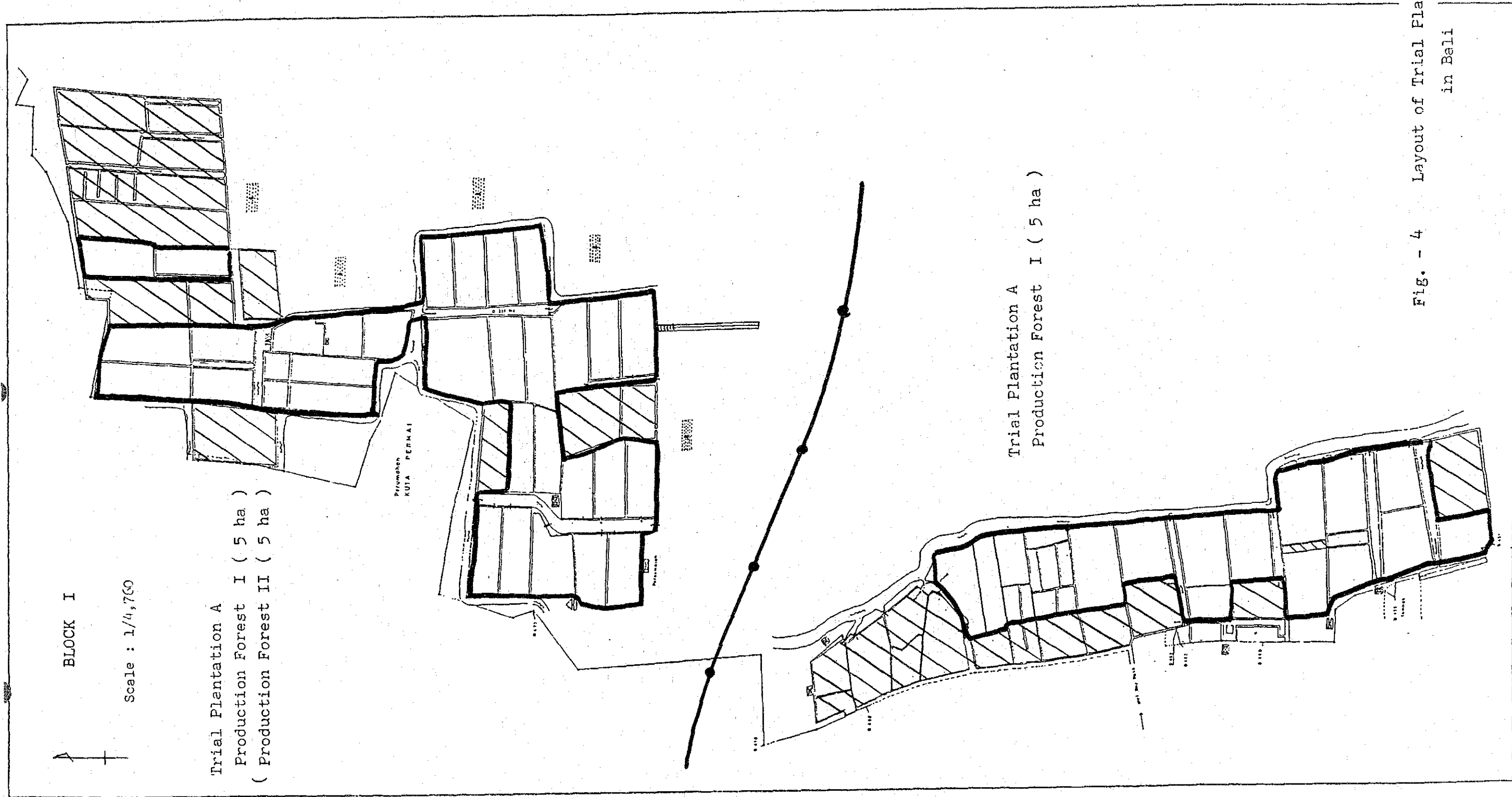


Fig. - 4 Layout of Trial Plantation Site
 in Bali

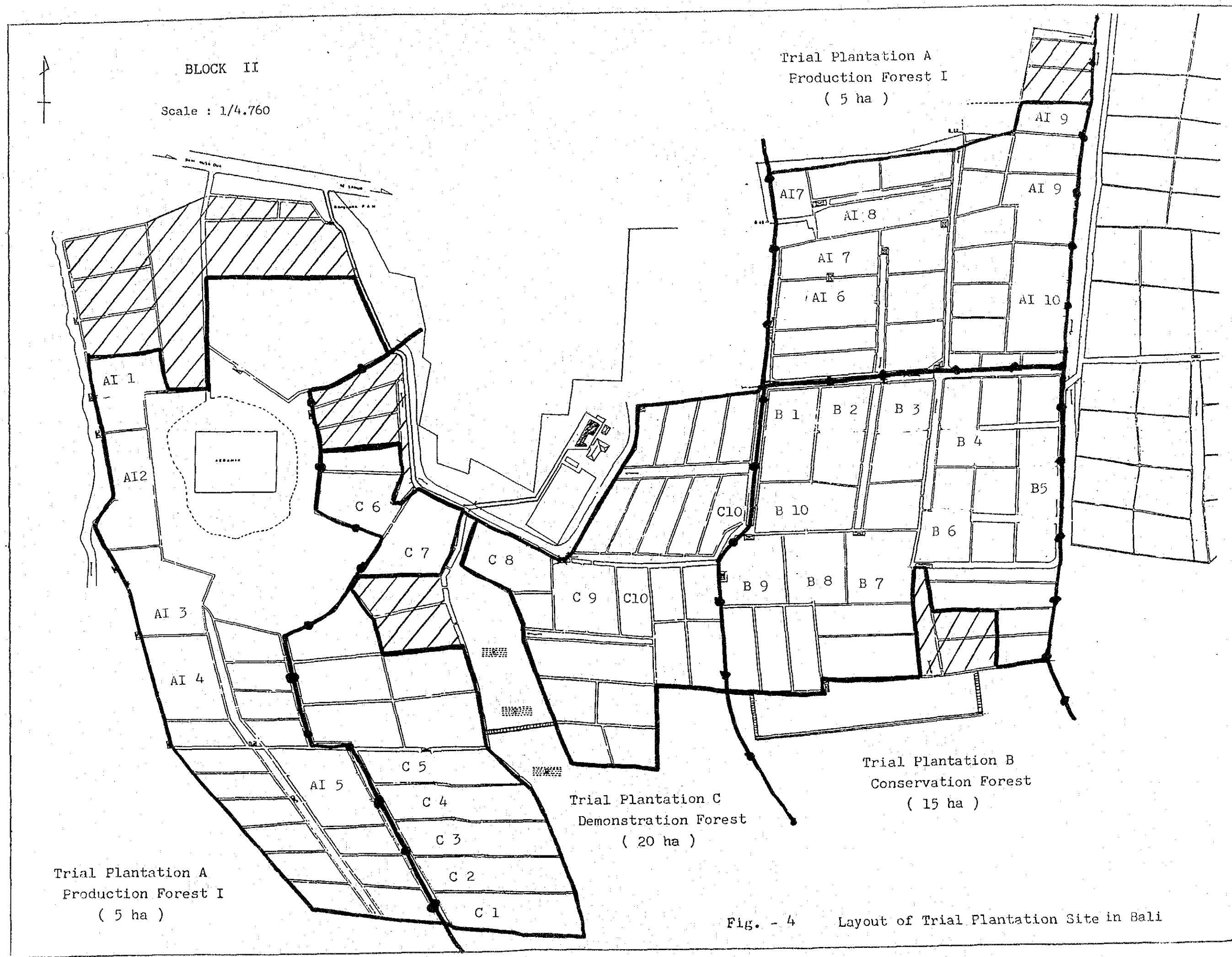


Fig. - 4 Layout of Trial Plantation Site in Bali

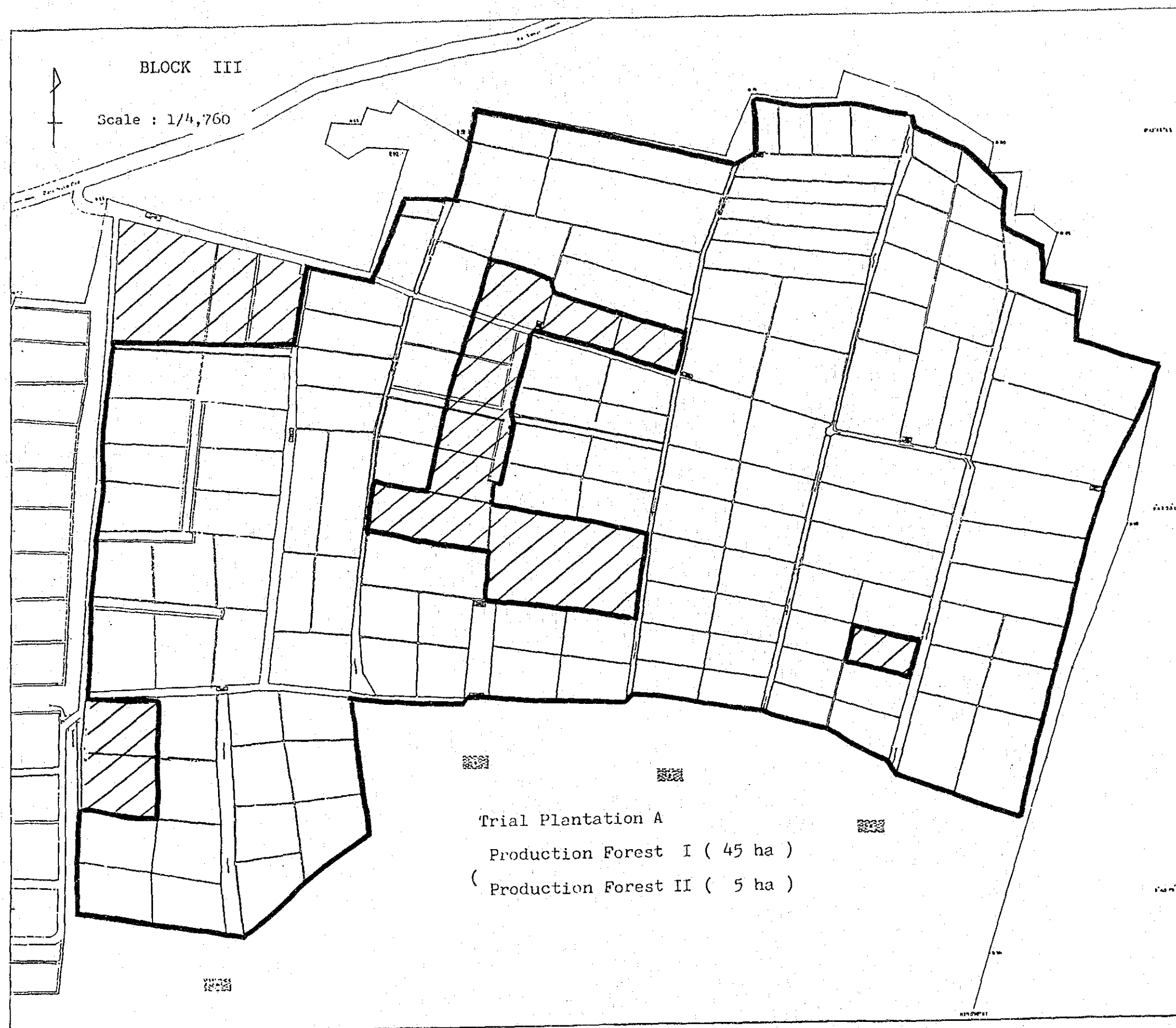


Fig. - 4 Layout of Trial Plantation Site in Bali

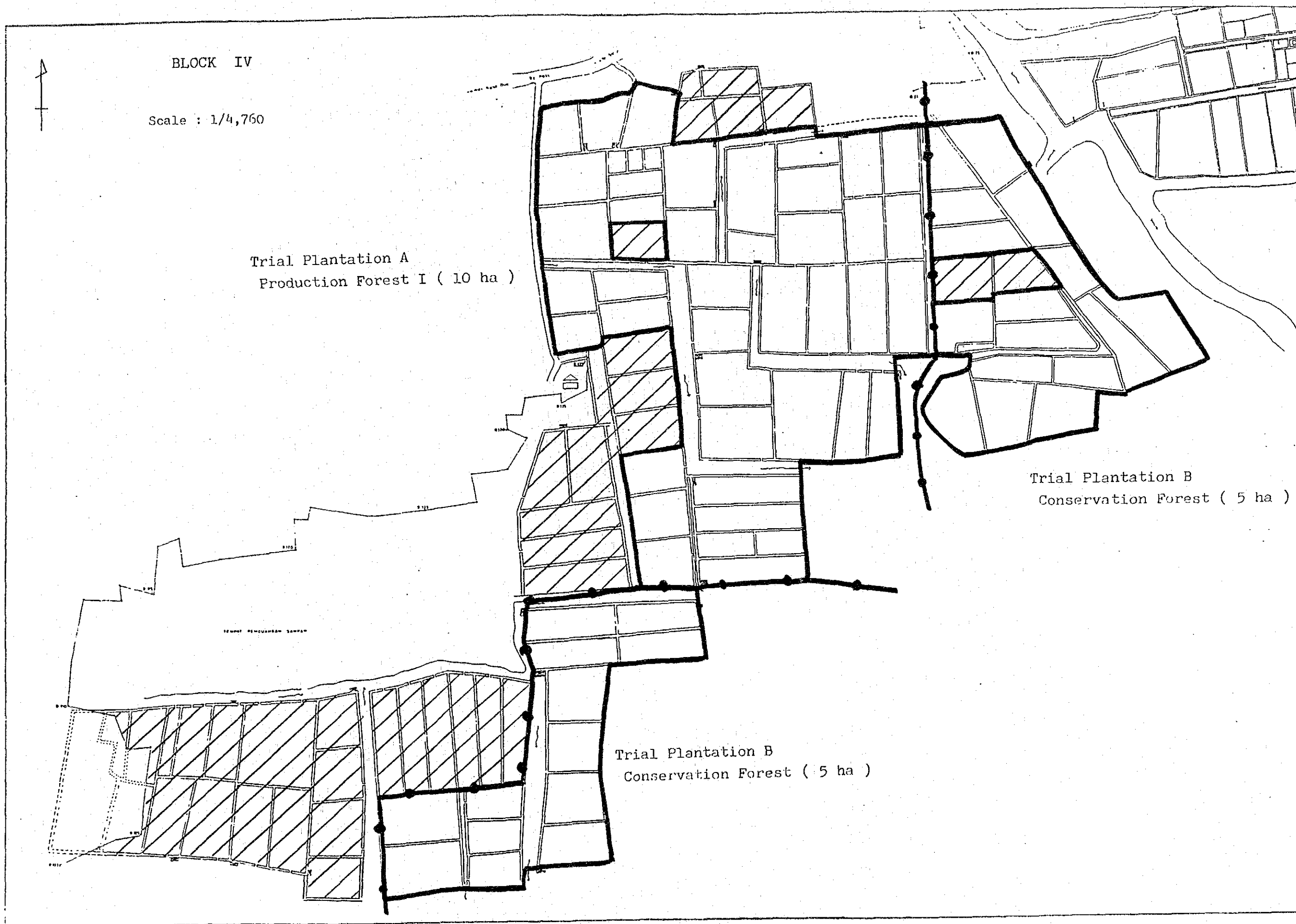


Fig. - 4 Layout of Trial Plantation Site in Bali

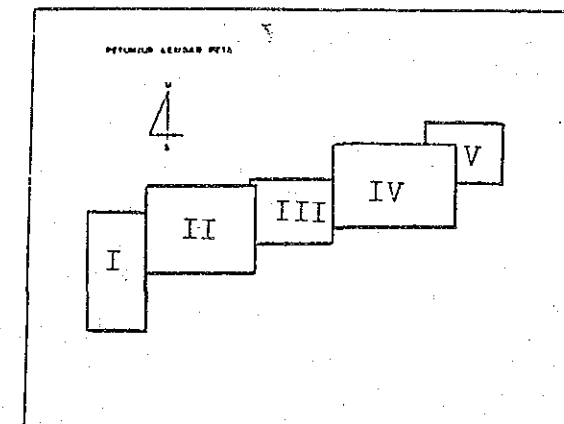
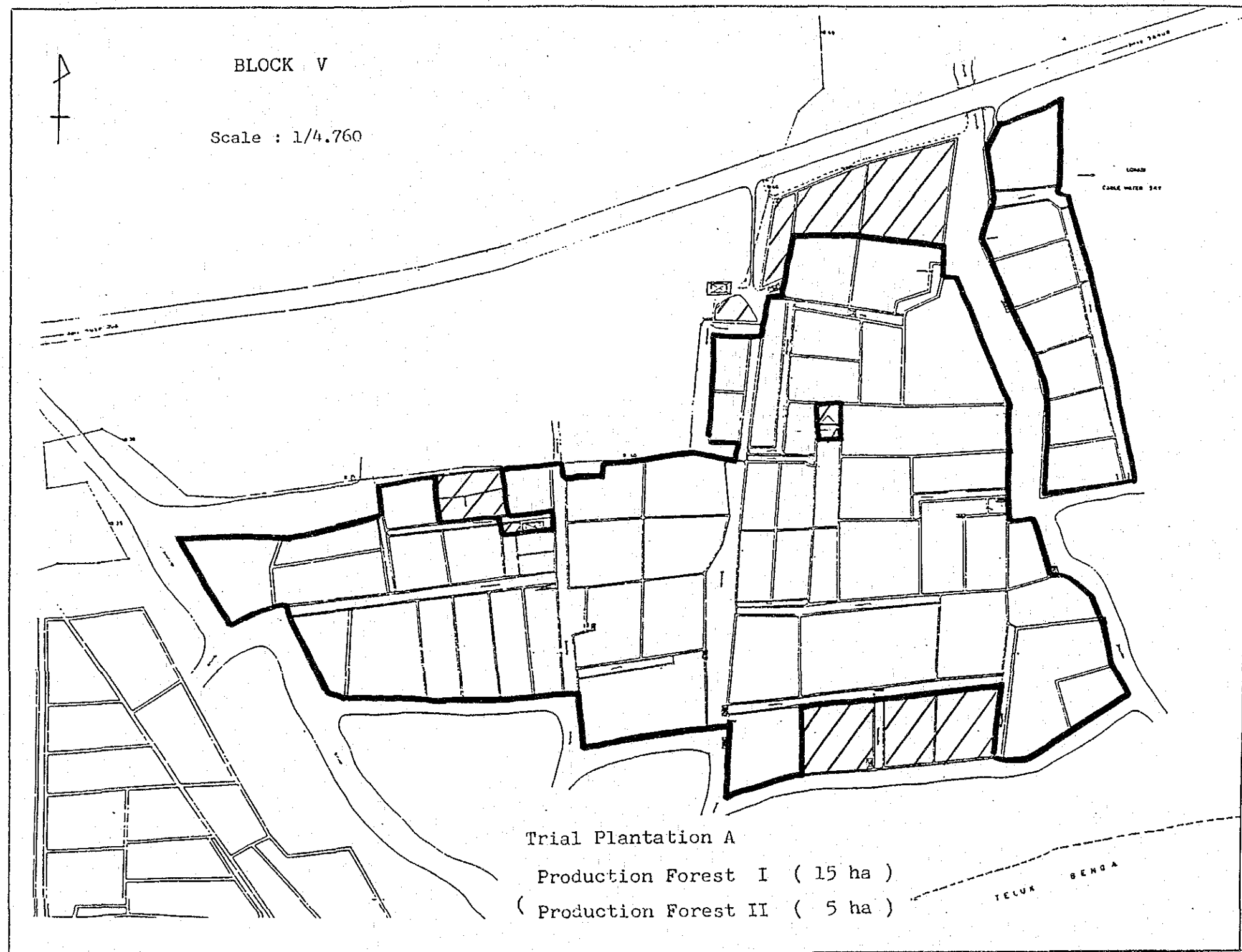


Fig. - 4 Layout of Trial Plantation Site in Bali

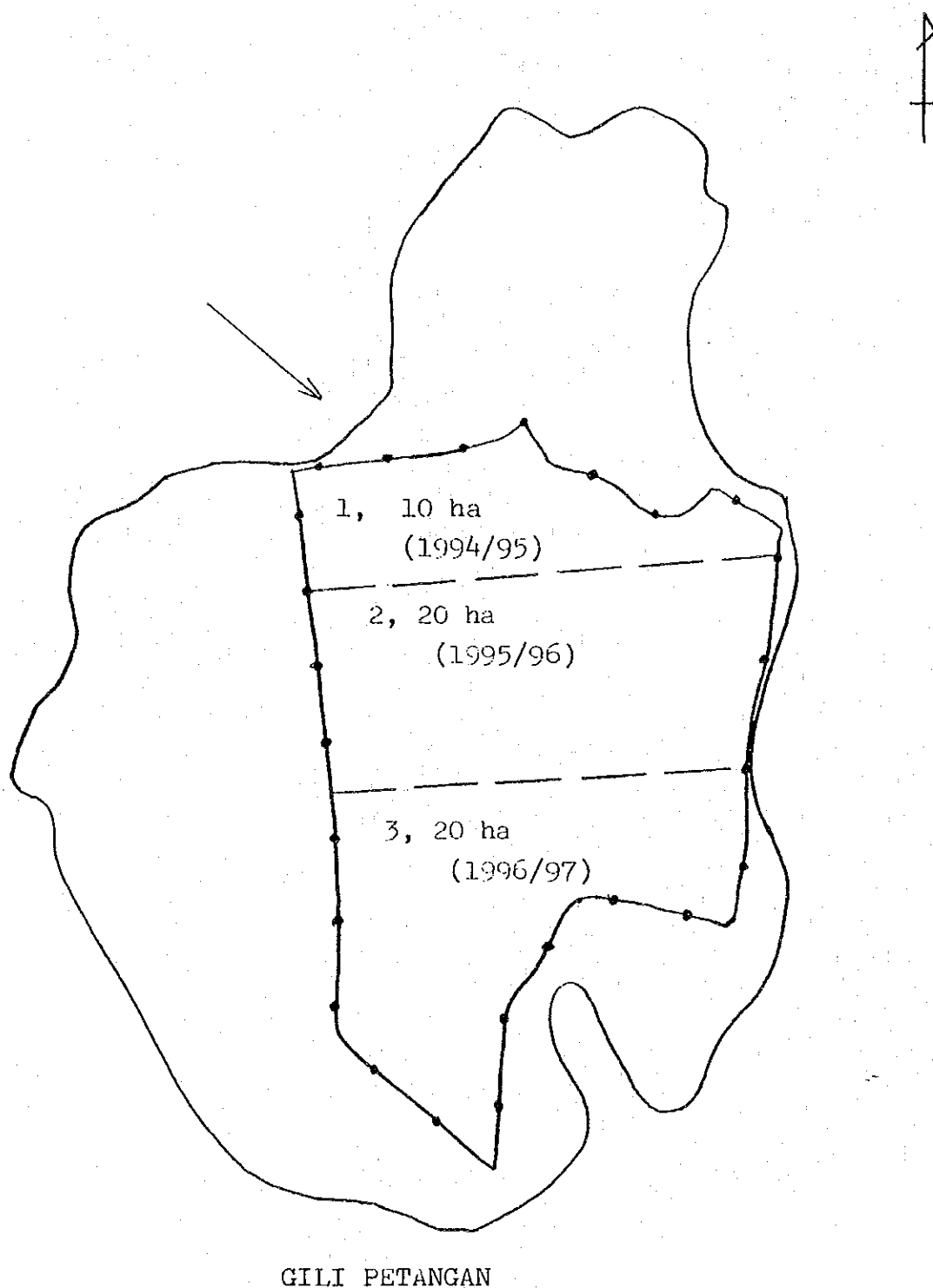


Fig. - 5 Trial Plantation Site in Lombok

(b) Production Forest II (Bali)

The five main tree species shall be planted. Experimental items on each species will be three types of nursing experiment concerning submergence depth, salinity and shading and the three planting methods being bare rooted seedlings of the five main species, direct seeding of Sonneratia sp. and Avicennia sp. and direct planting of Bruguiera and Rhizophora. Production Forest II will be used for the collection of experimental data and will be compared with the plantation site of Production Forest I.

There shall be one planting density and one seed provenance. Planting will be repeated 3 times in each species on each experimental plot by nursing experiment and planting methods.

(c) Conservation Forest (Bali)

The five main tree species shall be planted. Planting will be repeated four times in each species on each experimental plot by two planting densities and one provenance of seeds.

(d) Demonstration Forest (Bali)

Seven tree species shall be planted. Planting will be repeated two times in each species on each experimental plot by one planting density and seed provenances of each province of Indonesia. The planting area for each tree species shall be determined by the availability of seeds.

(e) Production Forest III (Lombok)

The site of Production Forest III at Gili Petangan is

Table-4 Annual Planting Area(1)

Trial Plantation	Site	Species	Spaciugs (m x m)	Acreage (ha)						Kind of Planting Stock	Seed provenance
				1st Year	2nd Year	3rd Year	4th Year	5th Year	Total		
Trial Plantation A	Production Forest I	Son sp	1 x 1	0.5	2	2	1.5		6	Potted Seedling	The following three provenance Bali Lombok-Java timur Java tengah Selecting one province form Java Barat, Riau Sulawesi Selatan
			1 x 2	0.5	2	6	1.5	4	6		
			2 x 2	1	2	2	1		6		
		Bru gym	1 x 1	0.5	2	2	1.5		6		
			1 x 2	0.5	2	6	1.5	4	6		
			2 x 2	1	2	2	1		6		
		Rhi api	1 x 1	0.5	2	2	1.5		6		
			1 x 2	0.5	2	6	1.5	4	6		
			2 x 2	1	2	2	1		6		
		Rhi muc	1 x 1	0.5	2	2	1.5		6		
			1 x 2	0.5	2	6	1.5	4	6		
			2 x 2	1	2	2	1		6		
		Awi sp	1 x 1	0.5	2	2	1.5		6		
			1 x 2	0.5	2	6	1.5	4	6		
			2 x 2	1	2	2	1		6		
		Sub Total		10	30	30	20	-	90		
Trial Plantation A	Production Forest II	Son sp	2 x 2		0.6	1	0.6	1	1.8	Potted Seedling of nursing test Bare rooted seedling/ Direct seeding Potted Seedling of nursing test Bare rooted seedling/ Direct Planting ditto ditto ditto ditto	Bail Lombok Java timur ditto ditto ditto ditto ditto
			2 x 2		0.4	0.4	0.4		1.2		
			2 x 2		0.6	0.6	0.6	1	1.8		
		Bru gym	2 x 2		0.4	1	0.4		1.2		
			2 x 2		0.6	0.6	0.6	1	1.8		
			2 x 2		0.4	0.4	0.4		1.2		
		Rhi api	2 x 2		0.6	0.6	0.6	1	1.8		
			2 x 2		0.4	0.4	0.4		1.2		
			2 x 2		0.6	0.6	0.6	1	1.8		
		Rhi muc	2 x 2		0.6	0.6	0.6	1	1.8		
			2 x 2		0.4	0.4	0.4		1.2		
			2 x 2		0.6	0.6	0.6	1	1.8		

Table-4 Annual Planting Area(2)

Trial Plantation	Site	Species	Spacings (m x m)	Acreage (ha)					Kind of Planting Stock	Seed provenance	
				1st Year	2nd Year	3rd Year	4th Year	5th Year			
				Total	Total	Total	Total	Total			
Trial Plantation A	Production Forest III	Avi sp	2 x 2		0.6	0.6	0.6	1.8	Potted seedling of nursing test Bare rooted seedling/ Direct Seeding	Bali Lombok--Jave Timur	
		2 x 2		0.4	1	0.4	1.2				
	Sub Total			5	5	5	15				
	Production Forest III	Son sp	1 x 2		0.5	1	2	1	2.5	Potted Seedling	Bali - Lombok-Jave Timur
			2 x 2		0.5	1	1	2.5			
		Bru gym	1 x 2		0.5	1	1	1	2.5	Potted Seedling	
			2 x 2		0.5	1	4	1	2.5		
			1 x 2		0.5	1	1	1	2.5		
			2 x 2		0.5	1	1	1	2.5		
		Rhi api	1 x 1		0.5	1	1	1	2.5	Potted Seedling	
			1 x 2		0.5	1	6	1	2.5		
			2 x 2		0.5	3	1	1	2.5		
			1 x 1		0.5	1	1	1	2.5		
Rhi muc	1 x 1		0.5	1	1	1	2.5	Potted Seedling			
	1 x 2		0.5	1	1	1	2.5				
	2 x 2		0.5	1	1	1	2.5				
	1 x 1		0.5	1	6	1	2.5				
Avi sp	1 x 2		0.5	3	1	1	2.5	Direct Planting			
	1 x 2		0.5	1	1	1	2.5				
	2 x 2		0.5	1	1	1	2.5				
	2 x 2		0.5	1	1	1	2.5				
Avi sp	1 x 2		0.5	1	2	1	2.5	Potted Seedling			
	2 x 2		0.5	1	1	1	2.5				
Sub Total				10	45	20	20	50			
Total				10	45	55	45	155			

Table-4 Annual Planting Area(3)

Trial Plantation	Site	Species	Spaciugs (m×m)	Acreage (ha)					Kind of Planting Stock	Seed provenance			
				1st Year	2nd Year	3rd Year	4th Year	5th Year			Total		
Trial Plantation B Production Forest III	L o m b o k	Son sp	2 × 2	1	0.5	0.5	0.5	1	0.5	1	2.5	Bali · Lombok-Jave timur	
			2 × 3	1	0.5	0.5	0.5	0.5	0.5	2.5			
		Bru gym	2 × 2	1	0.5	0.5	1	0.5	1	2.5	5		
			2 × 3	1	0.5	0.5	0.5	0.5	2.5				
		Rhi api	2 × 2	1	0.5	0.5	1	0.5	1	2.5	5		
			2 × 3	1	0.5	0.5	0.5	0.5	2.5				
		Rhi muc	2 × 2	1	0.5	0.5	1	0.5	1	2.5	5		
			2 × 3	1	0.5	0.5	0.5	0.5	2.5				
		Avi sp	2 × 2	1	0.5	0.5	0.5	1	0.5	1	2.5		5
			2 × 3	1	0.5	0.5	0.5	0.5	2.5				
		Total		10	5	5	5	5	25				
Trial Plantation C Demonstration Forest	B a l i	Son sp	2 × 2	1.5	1.5						3	The following province · Bali · Lombok Jave Timur · Java Tengah · Jave Barat · Riau · Sulawesi Selatan · Other province of Kalimantan Maluku, Irian and NTT	
		Bru gym	2 × 2	1.5	1.5						3		
		Rhi api	2 × 2	1.5	1.5						3		
		Rhi muc	2 × 2	1.5	1.5						3		
		Avi sp	2 × 2	1.5	1.5						3		
		Cer tag	2 × 2	1.5	1.5						3		
		Xyl gra	2 × 2	1.0	1.0						2		
		Total		10	10						20		
					30	60	60	60	50		200		
		G. Total		Bali	30	50	40	30			150		
		Lombok	0	10	20	20			50				

the cleared remains of a natural landform. Also, the Provincial Forestry Service has carried out a model plantation by direct planting of Rhizophora spp. at Lombok. In consideration of these points, direct planting of Bruguiera gymnorhiza and Rhizophora spp. shall also be carried out at Production Forest III.

The five main tree species shall be planted. There shall be two planting densities for Sonneratia sp. and Avicennia sp. and two planting densities of potted seedlings for Bruguiera gymnorhiza. There shall be three planting densities for the planting of potted seedlings or for direct planting of Rhizophora spp. There shall be one provenance of seeds for each tree species. Planting will be repeated 3 times in each species and on each experimental plot by densities and provenance.

Summarising the above, the plan for planting each year are as follows. (See Table 4)

Areas of planting sites are summarized in Table 5 on the basis of Table 4.

Table 5 Areas of Planting Sites by the Block and by the Year

Block No.	Area	Trial plantation A				Trial plantation B				Trial plantation C	
		Production forest I				Production forest II				Conservation forest	
		93	94	95	96	93	94	95	96	93	94
I	15		10				5				
II	45	10								10	10
III	50		20	25			5				
IV	20			5	5					5	5
V	20				15			5			
Total	150	10	30	30	20		5	5	5	10	10
		90				15				25	
										20	

5) Criteria for Plantation Work

(1) Demarcation of plantation site boundaries

Since the proposed plantation sites are all former 0.300 to 0.600 ha of Tambak ponds, two or three Tambaks shall be combined into areas of about one hectare and the various boundaries defined.

(2) Preparations

The Tambak embankments should be removed, or openings made in them as large as possible, so that the flow-in and flow-out of the sea water with tide shall be nearly natural over the whole of the area of the proposed plantation sites. In this way the sea water within each sector shall be changed smoothly and not become stagnant.

(3) Planting

Marker posts shall be erected according to the spacings to be used for planting in the various parts of the plantations. Since conditions for footings etc. are bad, and that the workable time is limited, workers shall be assigned efficiently to the each tasks such as digging planting holes, carrying the seedlings and planting. When planting out, it shall be emphasised that the seedlings are to be removed from the plastic pots.

(4) Tending

After one year, supplementary planting will be carried out in each trial plantation as follows:

- Production Forest I - In principal, supplementary planting

will be carried out in the locations where the group death occurs with respect to such such locations, the landform of the former Tambak, water levels, quality of the substrate, etc. shall be investigated to determine the cause of the group death.

- Production Forest II - Supplementary planting shall be carried out.
- Production Forest III - In principle, supplementary planting will not be carried out. It is the cutover lands of a natural forest and, since it is a natural area, it shall be used for the collection of data for the creation of an industrial production forest under these conditions. Even so, the cause of death shall be investigated. Also, since it is subject to the direct influence of waves from the open sea, methods of wave dissipation works shall be studied.
- Conservation Forest - In principle, supplementary planting will be carried out in respect of group death.
- Demonstration Forest - Supplementary planting will be carried out.

6) Work Procedures

Plantation work from the first year to the fifth year shall be carried out in accordance with the yearly work plans shown in Table 6. In addition, the distribution of workers shall be studied.

Both the plantation and the nursery are subject to the influence of the tide and it will be necessary to study working hours. For this reason, tide tables shall be obtained for each year to form the basis for drawing up actual work programs. For information, 1993 tide tables for Benoa Bay, Bali are appended. (See Appendix Table 9-4)

Table 6 Annual Work Program

Year		(1992) Year 1 (1993)												Year 2 (1994)						
Item		11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5
Seed acquisition											93									
Nursing																				94
Planting										93										
Supplementary planting (after 1 year)																93				

Year		(1994) Year 2						(1995) Year 3												
Item		6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Seed acquisition				94												95				
Nursing																				
Planting				94												95				
Supplementary planting (after 1 year)								94											95	
							93													94

Year		(1996) Year 4												(1997) Year 5						
Item		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7
Seed acquisition									96											
Nursing																				
Planting									96											
Supplementary planting (after 1 year)		95												96						
												95								

Year		(1997) Year 5																			
Item		8	9	10	11	12															
Seed acquisition																					
Nursing																					
Planting																					
Supplementary planting (after 1 year)						96															

2-6 Plan for Nursery

1) Nursery Practices

Seedlings for the trial plantation will be produced according to the following manner in a nursery to be established within this Project. Since this nursery is under construction, the seedlings to be planted in 1993 will be produced in former Tambak.

(1) In general, potted seedlings will be grown in a ordinary nursery for industrial use. The level of nursery bed should be slightly higher than the mean tidal height, which allows the sea water control by natural tide.

(2) Seedlings for the production forest II will be grown in a test nursery for the experiments of submergence depth, salinity and shading.

(3) The section of nursery for the experiment of submergence depth will be enclosed with a concrete wall which has a sufficient height to prevent the entrance of sea water at high water. The submergence depth will be adjusted to the necessary value by means of blocks.

(4) The section of nursery for the experiment of salinity will be enclosed with a concrete wall which has a sufficient height to prevent the entrance of sea water at high water. The salinity of the experiment will be artificially adjusted based on the salinity observed at the project site.

(5) For the experiment of shading, seedlings will be grown with shading (victory lawn) to make a comparison with those grown in the ordinary nursery for industrial use.

(6) Bare rooted seedlings used for the Production Forest II will be grown in the ordinary nursery for industrial use.

The work standards for nursing are as follows:

(a) Acquisition (Purchase) of seeds

For the provenance in Bali, Lombok and Java Timur, seeds will be collected in Bali and Lombok region and purchased from Java Timur if the quantity is not sufficient. The seeds produced from the other regions will be only purchased.

(b) Stockage of seeds

Rhizophoraceae produces a seedling as the propagating organ from fruit (viviparous seeds) and Avicennia spp. of Verbenaceae semi-viviparous seeds. Since both kinds have no dormant period, it is difficult to stock their seeds. Therefore, the nursing should be begun as soon as possible after the acquisition of their seeds.

(c) Nursing soil

Soil for pot nursing will be collected from the bank of Tambak. In this case, after putting soil, these pots will be set side by side so that the same condition will be obtained by natural tide.

(d) Germination box

Seeds of Sonneratia sp. and Avicennia sp. germed in a box will be transplanted into pots. The germination box has a form of approximately 50 cm(L) x 50 cm(W) x 10 cm(D). For Sonneratia sp., the direct seeding on the former Tambak will be experimented in order to use them as bare rooted wildings.

(e) Germination acceleration

Viviparous seeds of Rhizophoraceae sp. have their cap in the moment of collection. The transplantation into pots will be carried out after the immersion for a few days which will facilitate a slip-off of caps.

(f) Control on the nursery bed

Viviparous seeds of Rhizophoraceae sp. will be directly put into pots. Since their dried and hardened caps which are difficult to fall down naturally disturb the growth of young seedlings, it is necessary to carry out a regular inspection so as to take off caps.

(g) Delivery of seedlings

In Indonesia, seedlings are generally delivered after 4 months nursing. In this project also, the same period of nursing will be, for a while, applied before the delivery. However, the seedlings to be planted in sand deposit area in the seaward of natural forest which is directly affected by waves need to be grown for more than one year.

2) Production quantity of nursery stock

The number of seedlings to be produced according to the Trial Plantation Plan is given in Table 7

- Production quantity of nursery stock by year (Recapitulative Table) and the details are shown in Table 8.
- Number of seedlings to be produced by species and by trial plantation sites.

3) Plan for establishment of nursery

In this Project, a nursery will be created in order to promote trial plantation activities. The trial plantation aims to establish the technology for the creation of industrial forest. The permanent nursery will be constructed in consideration of future industrialization. The nursery covers an area of 5,840 m² of which 5,293 m² are used as an ordinary nursery for industrial use and 547 m² as an specific nursery for experiments.

The site of projected nursery is located in Block II of Benoa Prapat national forest land in Bali which is actually grass land adjacent to the Facilities Area such as office, etc.

Table-7 Annual quantity of stock production

Site	Species	1st Year			2nd Year			3rd Year			4th Year			Total		
		Potted seedling	Bare root	Direct Seeding	Potted seedling	Bare root	Direct Seeding	Potted seedling	Bare root	Direct Seeding	Potted seedling	Bare root	Direct Seeding	Potted seedling	Bare root	Direct Seeding
Bali	Son sp	23890			56450	670	500	51450	670	500	38110	670	500	169900	2010	1500
		23890			57120			52120			38780			171910		
	Bru gym	23890			56450	670	500	51450	670	500	38110	670	500	169900	2010	1500
		23890			57120			52120			38780			171910		
	Rhi api	23890			56450	670	500	51450	670	500	38110	670	500	169900	2010	1500
		23890			57120			52120			38780			171910		
	Rhi muc	23890			56450	670	500	51450	670	500	38110	670	500	169900	2010	1500
		23890			57120			52120			38780			171910		
	Avi sp	23890			56450	670	500	51450	670	500	38110	670	500	169900	2010	1500
		23890			57120			52120			38780			171910		
Bali	Cer tag	5000			5000									10000		
		5000			5000									1000		
	Xly gra	3340			3340									6680		
		3340			3340									6680		
	Total	127790			290590	3350	2500	257250	3350	2500	190550	3350	2500	866180	10050	7500
		127790			293940			260600			193900			876230		
	Son sp				5000			10000			10000			25000		
	Bru gym				5000		3750	10000		7500	10000		7500	25000		18750
	Rhi api				11670		8750	23330		17500	23330		17500	58330		43750
	Rhi unc				11670		8750	23330		17500	23330		17500	58330		43750
Loa-bok	Avi sp				5000			10000			10000			25000		
					36340		21250	76660		42500	76660		42500	191660		106250
	Total				328930	3350	23750	333910	3350	45000	267210	3350	45000	1057840	10050	113750
		127790			332280			337260			270560			1067890		
	G. Total															

Table-8

Stock production in each year(1)

① First year (1993)

Item of Trial plantation		Species	Acreage (ha)	Trees per ha (Spacing)	Planting Stock			Nursing Stock		Remarks
					Planting	Replanting	Total	Total		
Trial Plantation A	Production Forest I (Bali)	Son sp	0.5	1x1 (10000)	5000	1000	6000	6670	13330	Potted seedling
			0.5	1x2 (5000)	2500	500	3000	3330		
			1	2x2 (2500)	2500	500	3000	3330		
		Bru gym	0.5	1x1 (10000)	5000	1000	6000	6670	13330	"
			0.5	1x2 (5000)	2500	500	3000	3330		
			1	2x2 (2500)	2500	500	3000	3330		
		Rhi api	0.5	1x1 (10000)	5000	1000	6000	6670	13330	"
			0.5	1x2 (5000)	2500	500	3000	3330		
			1	2x2 (2500)	2500	500	3000	3330		
		Rhi muc	0.5	1x1 (10000)	5000	1000	6000	6670	13330	"
			0.5	1x2 (5000)	2500	500	3000	3330		
			1	2x2 (2500)	2500	500	3000	3330		
		Avi sp	0.5	1x1 (10000)	5000	1000	6000	6670	13330	"
			0.5	1x2 (5000)	2500	500	3000	3330		
			1	2x2 (2500)	2500	500	3000	3330		
		Sub total	10		50000	10000	60000	66650	66650	
Trial Plantation B	Conservation Forest (Bali)	Son sp	1	2500 (2x2)	2500	500	3000	3335	5560	Potted seedling
			1	1666 (2x3)	1666	334	2000	2225		
		Bru gym	1	2500 (2x2)	2500	500	3000	3335	5560	"
			1	1666 (2x3)	1666	334	2000	2225		
		Rhi api	1	2500 (2x2)	2500	500	3000	3335	5560	"
			1	1666 (2x3)	1666	334	2000	2225		
		Rhi muc	1	2500 (2x2)	2500	500	3000	3335	5560	"
			1	1666 (2x3)	1666	334	2000	2225		
		Avi sp	1	2500 (2x2)	2500	500	3000	3335	5560	"
			1	1666 (2x3)	1666	334	2000	2225		
		Sub total	10		20830	4170	25000	27800	27800	
Trial Plantation C	Demonstration Forest (Bali)	Son sp	1.5	2500 (2x2)	3750	750	4500	5000		Potted seedling
		Bru gym	1.5	2500 (2x2)	3750	750	4500	5000		"
		Rhi api	1.5	2500 (2x2)	3750	750	4500	5000		"
		Rhi muc	1.5	2500 (2x2)	3750	750	4500	5000	33340	"
		Avi sp	1.5	2500 (2x2)	3750	750	4500	5000		"
		Cer tag	1.5	2500 (2x2)	3750	750	4500	5000		"
		Xyl gro	1.0	2500 (2x2)	2500	500	3000	3340		"
		Sub total	10		25000	5000	30000	33340	33340	
G. total					95830	19170	115000	127790	127790	

Table-8

Stock production in each year (2)

② Second year (1994)

Item of trial plantation		Species	Acreage (ha)	Trees per ha (Spacing)	Planting Stock			Nursing Stock		Remarks
					Planting	Replanting	Total	Total		
Trial Plantation A	Production Forest I (Bali)	Son sp	2	10000 (1x1)	20000	4000	24000	26670	46670	Potted seedling
			2	5000 (1x2)	10000	2000	12000	13330		
			2	2500 (2x2)	5000	1000	6000	6670		
		Bru gym	2	10000 (1x1)	20000	4000	24000	26670	46670	"
			2	5000 (1x2)	10000	2000	12000	13330		
			2	2500 (2x2)	5000	1000	6000	6670		
		Rhi api	2	10000 (1x1)	20000	4000	24000	26670	46670	"
			2	5000 (1x2)	10000	2000	12000	13330		
			2	2500 (2x2)	5000	1000	6000	6670		
		Rhi muc	2	10000 (1x1)	20000	4000	24000	26670	46670	"
			2	5000 (1x2)	10000	2000	12000	13330		
			2	2500 (2x2)	5000	1000	6000	6670		
		Avi sp	2	10000 (1x1)	20000	4000	24000	26670	46670	"
			2	5000 (1x2)	10000	2000	12000	13330		
			2	25000 (2x2)	5000	1000	6000	6670		
		Sub total	30		17500	35000	210000	233350	233350	
	Production Forest II (Bali)	Son sp	0.6	2500 (2x2)	1500	300	1800	2000	2000	Potted seedling
			0.2	2500 (2x2)	500	100	600	670	670	Bare rooted seedling
			0.2	2500 (2x2)	500					Direct seedling
		Bru api	0.6	2500 (2x2)	1500	300	1800	2000	2000	Potted seedling
			0.2	2500 (2x2)	500	100	600	670	670	Bare rooted seedling
			0.2	2500 (2x2)	500					Direct planting
		Rhi api	0.6	2500 (1x1)	1500	300	1800	2000	2000	Potted seedling
			0.2	2500 (1x1)	500	100	600	670	670	Bare rooted seedling
			0.2	2500 (1x1)	500					Direct planting
		Rhi muc	0.6	2500 (1x1)	1500	300	1800	2000	2000	Potted seedling
			0.2	2500 (1x1)	500	100	600	670	670	Bare rooted seedling
			0.2	2500 (1x1)	500					Direct planting
		Avi sp	0.6	2500 (1x1)	1500	300	1800	2000	2000	Potted seedling
			0.2	2500 (1x1)	500	100	600	670	670	Bare rooted seedling
			0.2	2500 (1x1)	500					Direct planting
		Sub total	5							
			3	Potted seedling	7500	1500	9000	10000	13350	
			1	Bare rooted seedling	2500	500	3000	3350		
			0.6	Direct planting	*1500					*2500
			0.4	Direct seedling	*1000					

Table-8

Stock production in each year (3)

Item of Trial plantation		Species	Acreage (ha)	Trees per ha (Spacing)	Planting Stock			Nursing Stock		Remarks
					Planting	Replanting	Total	Total		
Trial Plantation B	Conservation Forest (Bali)	Son sp	0.5	2500 (2x2)	1250	250	1500	1670	2780	Potted seedling
			0.5	1666 (2x3)	833	167	1000	1110		
		Bru gym	0.5	2500 (2x2)	1250	250	1500	1670	2780	"
			0.5	1666 (2x3)	833	167	1000	1110		
		Rhi api	0.5	2500 (2x2)	1250	250	1500	1670	2780	"
			0.5	1666 (2x3)	833	167	1000	1110		
		Rhi muc	0.5	2500 (2x2)	1250	250	1500	1670	2780	"
			0.5	1666 (2x3)	833	167	1000	1110		
		Avi sp	0.5	2500 (2x2)	1250	250	1500	1670	2780	"
			0.5	1666 (2x3)	833	167	1000	1110		
Sub total			5		10415	2085	12500	13900	3900	
Trial Plantation C	Demonstration Forest (Bali)	Son sp	1.5	2500 (2x2)	3750	750	4500	5000		
		Bru gym	1.5	2500 (2x2)	3750	750	4500	5000		
		Rhi api	1.5	2500 (2x2)	3750	750	4500	5000		
		Rhi muc	1.5	2500 (2x2)	3750	750	4500	5000		
		Avi sp	1.5	2500 (2x2)	3750	750	4500	5000		
		Cer tag	1.5	2500 (2x2)	3750	750	4500	5000	33340	Potted seedling
		Xyl gra	1.0	2500 (2x2)	2500	500	4500	3340		
		Sub total	10		25000	5000	30000	33340		
Total (Bali)			50							
			48	Potted seedling	217915	43585	261500	290590	293940	
			1	Bare rooted seedling	2500	500	3000	3350		
			0.6	Direct planting	※1500					
			0.4	Direct seedling	※1000					2500
Trial Plantation A	Production Forest III (Lombok)	Son sp	0.5	5000 (1x2)	2500	500	3000	3330	5000	Potted seedling
			0.5	2500 (2x2)	1250	250	1500	1670		
		Bru gym	0.5	5000 (1x2)	2500	500	3000	3330	5000	Potted seedling
			0.5	2500 (2x2)	1250	250	1500	1670		
			0.5	5000 (1x2)	2500	3750				Direct planting
			0.5	2500 (2x2)	1250					
		Rhi api	0.5	10000 (1x1)	5000	1000	6000	6670		Potted seedling
			0.5	5000 (1x2)	2500	500	3000	3330	11670	
			0.5	2500 (2x2)	1250	250	1500	1670		
			0.5	10000 (1x1)	5000	8750				Direct planting
			0.5	5000 (1x2)	2500					
			0.5	2500 (2x2)	1250					

Table-8

Stock production in each year(4)

Item of trial plantation		Species	Acreage (ha)	Trees per ha (Spacing)	Planting Stock			Nursing Stock		Remarks
					Planting	Replanting	Total	Total		
Trial Plantation A	Production Forest III (Lombok)	Rhi muc	0.5	10000 (1x1)	5000	1000	6000	6670	11670	Potted seedling
			0.5	5000 (1x2)	2500	500	3000	3330		
			0.5	2500 (2x2)	1250	250	1500	1670		Potted seedling
			0.5	10000 (1x1)	5000	8750				Direct planting
			0.5	5000 (1x2)	2500					
			0.5	2500 (2x2)	1250					
		Avi sp	0.5	5000 (1x2)	2500	500	3000	3330	5000	Potted seedling
			0.5	2500 (2x2)	1250	250	1500	1670		
Total (Lombok)			10							
			7	Potted seedling	28750	5750	34500	38340	38340	
			3	Direct planting	※ 21250				21250	
G. total			60							
			55	Potted seedling	246665	49335	296000	328930	32280	
			1	Bare rooted seedling	2500	500	3000	3350		
			3.6	Direct planting	※ 22725				※ 23725	
			0.4	Direct seedling	※ 1000					

Table-8

Stock production in each year (5)

③ Third year (1995)

Item of Trial plantation		Species	Acreage (ha)	Trees per ha (Spacing)	Planting Stock			Nursing Stock		Remarks	
					Planting	Replanting	Total	Total			
Trial Plantation A	Production Forest I (Bali)	Son sp	2	10000 (1x1)	20000	4000	24000	26670	46670	Potted seedling	
			2	5000 (1x2)	10000	2000	12000	13330			
			2	2500 (2x2)	5000	1000	6000	6670		Potted seedling	
		Bru gym	2	10000 (1x1)	20000	4000	24000	26670	46670	Direct planting	
			2	5000 (1x2)	10000	2000	12000	13330			
			2	2500 (2x2)	5000	1000	6000	6670			
		Rhi api	2	10000 (1x2)	20000	4000	24000	26670	46670	Potted seedling	
			2	5000 (1x2)	10000	2000	12000	13330			
			2	2500 (2x2)	5000	1000	6000	6670			
		Rhi muc	2	10000 (1x1)	20000	4000	24000	26670	46670		
			2	5000 (1x2)	10000	2000	12000	13330			
			2	2500 (2x2)	5000	1000	6000	6670			
		Avi sp	2	10000 (1x1)	20000	4000	24000	26670	46670		
			2	5000 (1x2)	10000	2000	12000	13330			
			2	2500 (2x2)	5000	1000	6000	6670			
		Sub total	30		175000	35000	210000	233350			
	Production Forest II (Bali)	Son sp	0.6	2500 (2x2)	1500	300	1800	2000	2000	Potted seedling	
			0.2	2500 (2x2)	500	100	600	670	670	Bare rooted seedling	
			0.2	2500 (2x2)	500					Direct seedling	
		Bru gym	0.6	2500 (2x2)	1500	300	1800	2000	2000	Potted seedling	
			0.2	2500 (2x2)	500	100	600	670	670	Bare rooted seedling	
			0.2	2500 (2x2)	500					Direct seedling	
		Rhi api	0.6	2500 (2x2)	1500	300	1800	2000	2000	Potted seedling	
			0.2	2500 (2x2)	500	100	600	670	670	Bare rooted seedling	
			0.2	2500 (2x2)	500					Direct planting	
		Rhi muc	0.6	2500 (2x2)	1500	300	1800	2000	2000	Potted seedling	
			0.2	2500 (2x2)	500	100	600	670	670	Bare rooted seedling	
			0.2	2500 (2x2)	500					Direct planting	
		Avi sp	0.6	2500 (2x2)	1500	300	1800	2000	2000	Potted seedling	
			0.2	2500 (2x2)	500	100	600	670	670	Bare rooted seedling	
			0.2	2500 (2x2)	500					Direct seedling	
		Sub total	5								
			3	Potted seedling	7500	1500	9000	10000	13350		
			1	Bare rooted seedling	2500	500	3000	3350			
			0.4	Direct planting	※1500					※2500	
			0.6	Direct seedling	※1000						

Table-8

Stock production in each year (6)

Item of Trial plantation		Species	Acreage (ha)	Trees per ha (Spacing)	Planting Stock			Nursing Stock		Remarks	
					Planting	Replanting	Total	Total			
Trial Plantation A	Production Forest I (Bali)	Son sp	0.5	2500 (2x2)	1250	250	1500	1670	2780	Potted seedling	
			0.5	1666 (2x3)	833	167	1000	1110			
		Bru gym	0.5	2500 (2x2)	1250	250	1500	1670	2780	Potted seedling	
			0.5	1666 (2x3)	833	167	1000	1110			
		Rhi api	0.5	2500 (2x2)	1250	250	1500	1670	2780	Potted seedling	
			0.5	1666 (2x3)	833	167	1000	1110			
		Rhi muc	0.5	2500 (2x2)	1250	250	1500	1670	2780	Potted seedling	
			0.5	1666 (2x3)	833	167	1000	1110			
		Avi sp	0.5	2500 (2x2)	1250	250	1500	1670	2780	Potted seedling	
			0.5	1666 (2x3)	833	167	1000	1110			
Sub total			5		10415	2085	12500	13900	13900		
Total (Bali)			40								
			38	Potted seedling	192915	38585	231500	257250	260600		
			1	Bare rooted seedling	2500	500	3000	3350			
			0.6	Direct planting	※1500					※2500	
			0.4	Direct seedling	※1000						
Trial Plantation A	Production Forest III (Lombok)	Son sp	1	5000 (1x2)	5000	1000	6000	6670	10000	Potted seedling	
			1	2500 (2x2)	2500	500	3000	3330			
		Bru gym	1	5000 (1x2)	5000	1000	6000	6670	10000	Potted seedling	
			1	2500 (2x2)	2500	500	3000	3330			
			1	5000 (1x2)	5000	7500				Direct planting	
			1	2500 (2x2)	2500						
		Rhi api	1	10000 (1x1)	10000	2000	12000	13330		Potted seedling	
			1	5000 (1x2)	5000	1000	6000	6670	23330		
			1	2500 (2x2)	2500	500	3000	3330			
			1	10000 (1x1)	10000	17500				Direct planting	
			1	5000 (1x2)	5000						
			1	2500 (2x2)	2500						
		Rhi muc	1	10000 (1x1)	10000	2000	12000	13330		Potted seedling	
			1	5000 (1x2)	5000	1000	6000	6670	23330		
			1	2500 (2x2)	2500	500	3000	3330			
			1	10000 (1x1)	10000	17500				Direct planting	
			1	5000 (1x2)	5000						
			1	2500 (2x2)	2500						
		Avi sp	1	5000 (1x2)	5000	1000	6000	6670	10000	Potted seedling	
			1	2500 (2x2)	2500	500	3000	3330			

Table-8

Stock production in each year (7)

Item of trial plantation	Species	Acreage (ha)	Trees per ha (Spacing)	Planting Stock			Nursing Stock		Remarks
				Planting	Replanting	Total	Total		
Total(Lombok)		20							
		12	Potted seedling	57500	11500	69000	76660	76660	
		8	Direct planting	※ 42500			※ 42500		
G. total		60							
		50	Potted seedling	250415	50085	300500	333910	337260	
		1	Bare rooted seedling	2500	500	3000	3350		
		8.6	Direct planting	※ 44000				※ 45000	
		0.4	Direct seedling	※ 1000					

Table-8

Stock production in each year (8)

④ Fourth year (1996)

Item of Trial plantation		Species	Acreage (ha)	Trees per ha (Spacing)	Planting Stock			Nursing Stock		Remarks
					Planting	Replanting	Total	Total		
Trial Plantation A	Production Forest I (Bali)	Son sp	1.5	10000 (1x1)	15000	3000	18000	20000	33330	Potted seedling
			1.5	5000 (1x2)	7500	1500	9000	10000		
			1	2500 (2x2)	2500	500	3000	3330		
		Bru gym	1.5	10000 (1x1)	15000	3000	18000	20000	33330	Potted seedling
			1.5	5000 (1x2)	7500	1500	9000	10000		
			1	2500 (2x2)	2500	500	3000	3330		
		Rhi api	1.5	10000 (1x1)	15000	3000	18000	20000	33330	Potted seedling
			1.5	5000 (1x2)	7500	1500	9000	10000		
			1	2500 (2x2)	2500	500	3000	3330		
		Rhi muc	1.5	10000 (1x1)	15000	3000	18000	20000	33330	Potted seedling
			1.5	5000 (1x2)	7500	1500	9000	10000		
			1	2500 (2x2)	2500	500	3000	3330		
		Avi sp	1.5	10000 (1x1)	15000	3000	18000	20000	33330	Potted seedling
			1.5	5000 (1x2)	7500	1500	9000	10000		
			1	2500 (2x2)	2500	500	3000	3330		
		Sub total	20		125000	25000	150000	166650	166650	
	Production Forest II (Bali)	Son sp	0.6	2500 (2x2)	1500	300	1800	2000	2000	Potted seedling
			0.2	2500 (2x2)	500	100	600	670	670	Bare rooted seedling
			0.2	2500 (2x2)	500					Direct seedling
		Bru gym	0.6	2500 (2x2)	1500	300	1800	2000	2000	Potted seedling
			0.2	2500 (2x2)	500	100	600	670	670	Bare rooted seedling
			0.2	2500 (2x2)	500					Direct planting
		Rhi api	0.6	2500 (2x2)	1500	300	1800	2000	2000	Potted seedling
			0.2	2500 (2x2)	500	100	600	670	670	Bare rooted seedling
			0.2	2500 (2x2)	500					Direct planting
		Rhi muc	0.6	2500 (2x2)	1500	300	1800	2000	2000	Potted seedling
			0.2	2500 (2x2)	500	100	600	670	670	Bare rooted seedling
			0.2	2500 (2x2)	500					Direct planting
		Avi sp	0.6	2500 (2x2)	1500	300	1800	2000	2000	Potted seedling
			0.2	2500 (2x2)	500	100	600	670	670	Bare rooted seedling
			0.2	2500 (2x2)	500					Direct seedling
		Sub total	5							
			3	Potted seedling	7500	1500	9000	10000	13350	
			1	Bare rooted seedling	2500	500	3000	3350		
			0.6	Direct planting	※ 1500			※ 2500		
			0.4	Direct seedling	※ 1000					

Table-8

Stock production in each year (9)

Item of Trial plantation		Species	Acreage (ha)	Trees per ha (Spacing)	Planting Stock			Nursing Stock		Remarks
					Planting	Replanting	Total	Total		
Trial Plantation B	Conservation Forest (Bali)	Son sp	0.5	2500 (2x2)	1250	250	1500	1670	2780	Potted seedling
			0.5	1666 (2x3)	833	167	1000	1110		
		Bru gym	0.5	2500 (2x2)	1250	250	1500	1670	2780	Potted seedling
			0.5	1666 (2x3)	833	167	1000	1110		
		Rhi api	0.5	2500 (2x2)	1250	250	1500	1670	2780	Potted seedling
			0.5	1666 (2x3)	833	167	1000	1110		
		Rhi muc	0.5	2500 (2x2)	1250	250	1500	1670	2780	Potted seedling
			0.5	1666 (2x3)	833	167	1000	1110		
		Avi sp	0.5	2500 (2x2)	1250	250	1500	1670	2780	Potted seedling
			0.5	1666 (2x3)	833	167	1000	1110		
Sub total			5		10415	2085	12500	13900	13900	
Total (Bali)			30							
			28	Potted seedling	142915	28585	171500	190550	193900	Potted seedling
			1	Bare rooted seedling	2500	500	3000	3350		
			0.6	Direct planting	※ 1500				2500	
			04	Direct seedling	※ 1000					
Trial Plantation A	Production Forest III (Lombok)	Son sp	1	5000 (1x2)	5000	1000	6000	6670	10000	Potted seedling
			1	2500 (2x2)	2500	500	3000	3330		
		Bru gym	1	5000 (1x2)	5000	1000	6000	6670	10000	Potted seedling
			1	2500 (2x2)	2500	500	3000	3330		
			1	5000 (1x2)	5000	7500				Direct planting
			1	2500 (2x2)	2500					
		Rhi api	1	10000 (1x1)	10000	2000	12000	13330		Potted seedling
			1	5000 (1x2)	5000	1000	6000	6670	23330	
			1	2500 (2x2)	2500	500	3000	3330		
			1	10000 (1x1)	10000	17500				Direct planting
			1	5000 (1x2)	5000					
			1	2500 (2x2)	2500					
		Rhi muc	1	10000 (1x1)	10000	2000	12000	13330		Potted seedling
			1	5000 (1x2)	5000	1000	6000	6670	23330	
			1	2500 (2x2)	2500	500	3000	3330		
			1	10000 (1x1)	10000	17500				Direct planting
			1	5000 (1x2)	5000					
			1	2500 (2x2)	2500					
		Avi sp	1	5000 (1x2)	5000	1000	6000	6670	10000	Potted seedling
			1	2500 (2x2)	2500	500	3000	3330		

Table-8

Stock production in each year(10)

Item of trial plantation	Species	Acreage (ha)	Trees per ha (Spacing)	Planting Stock			Nursing Stock		Remarks
				Planting	Replanting	Total	Total		
Total(Lombok)		20							
		12	Potted seedling	57500	11500	69000	76660	76660	
		8	Direct planting	42500				42500	
G. total		50							
		40	Potted seedling	200415	40085	240500	267210	270560	
		1	Bare rooted seedling	2500	500	3000	3350		
		8.6	Direct planting	※ 44000				※ 45000	
		0.4	Direct seedling	※ 1000					

[illegible]

Fig. - 6 Working Road For Vehicle

BLOCK II

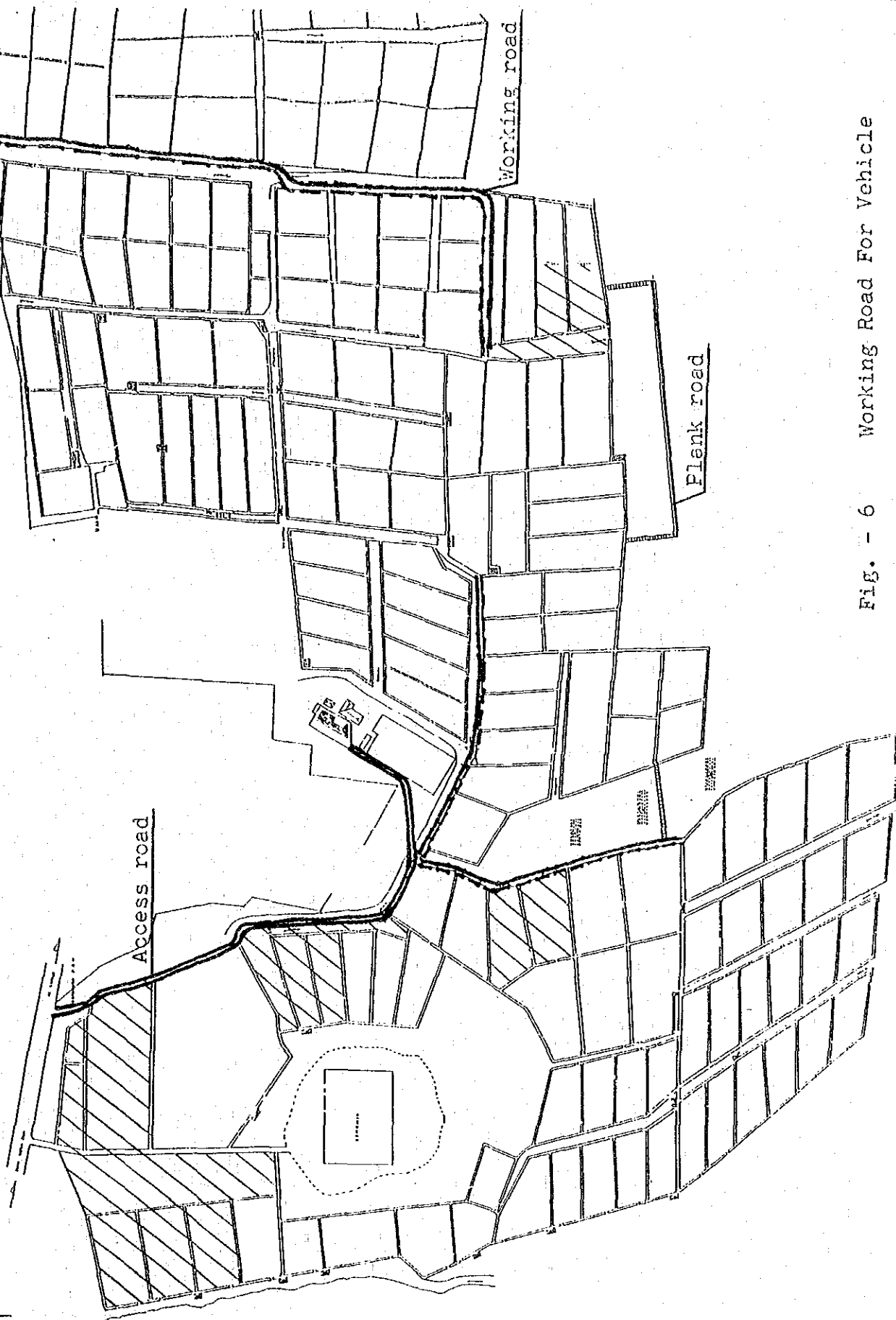


Fig. - 6 Working Road For Vehicle

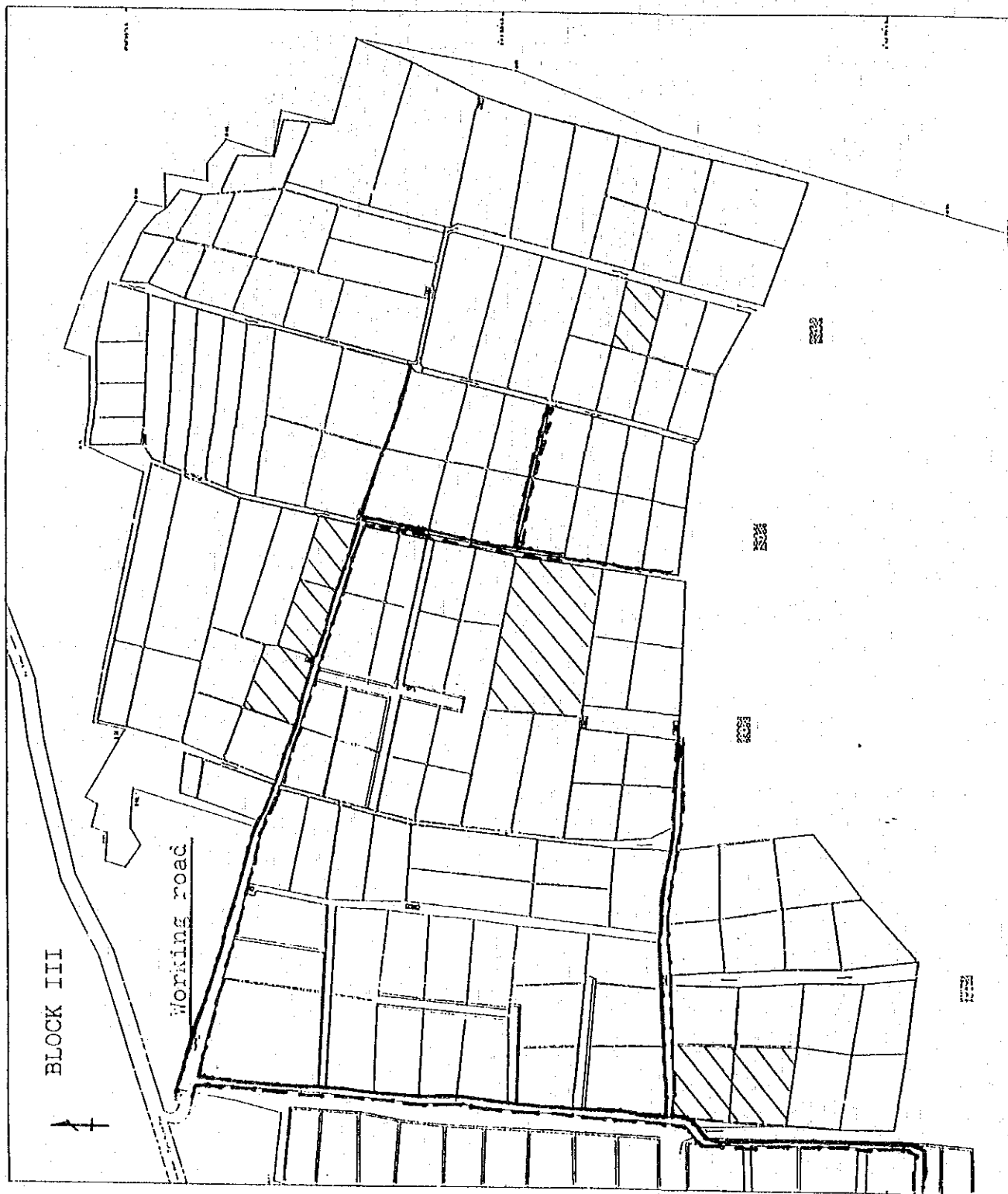


Fig. - 6 Working Road For Vehicle

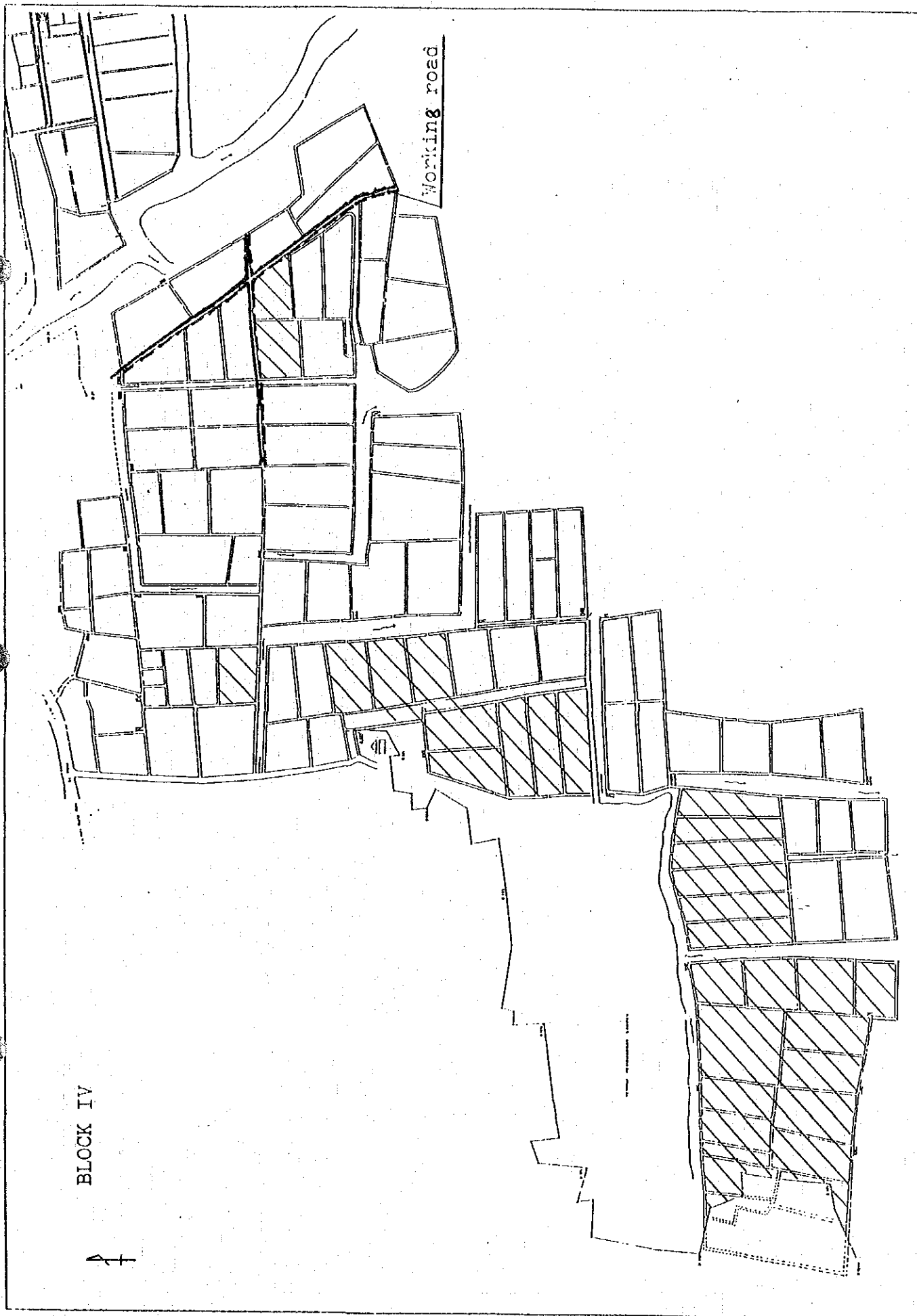


Fig. - 6 Working Road For Vehicle

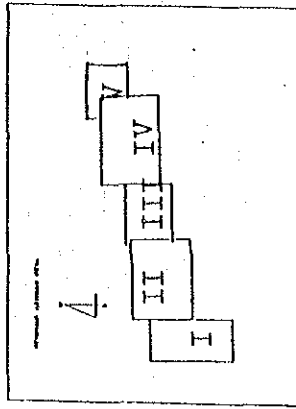
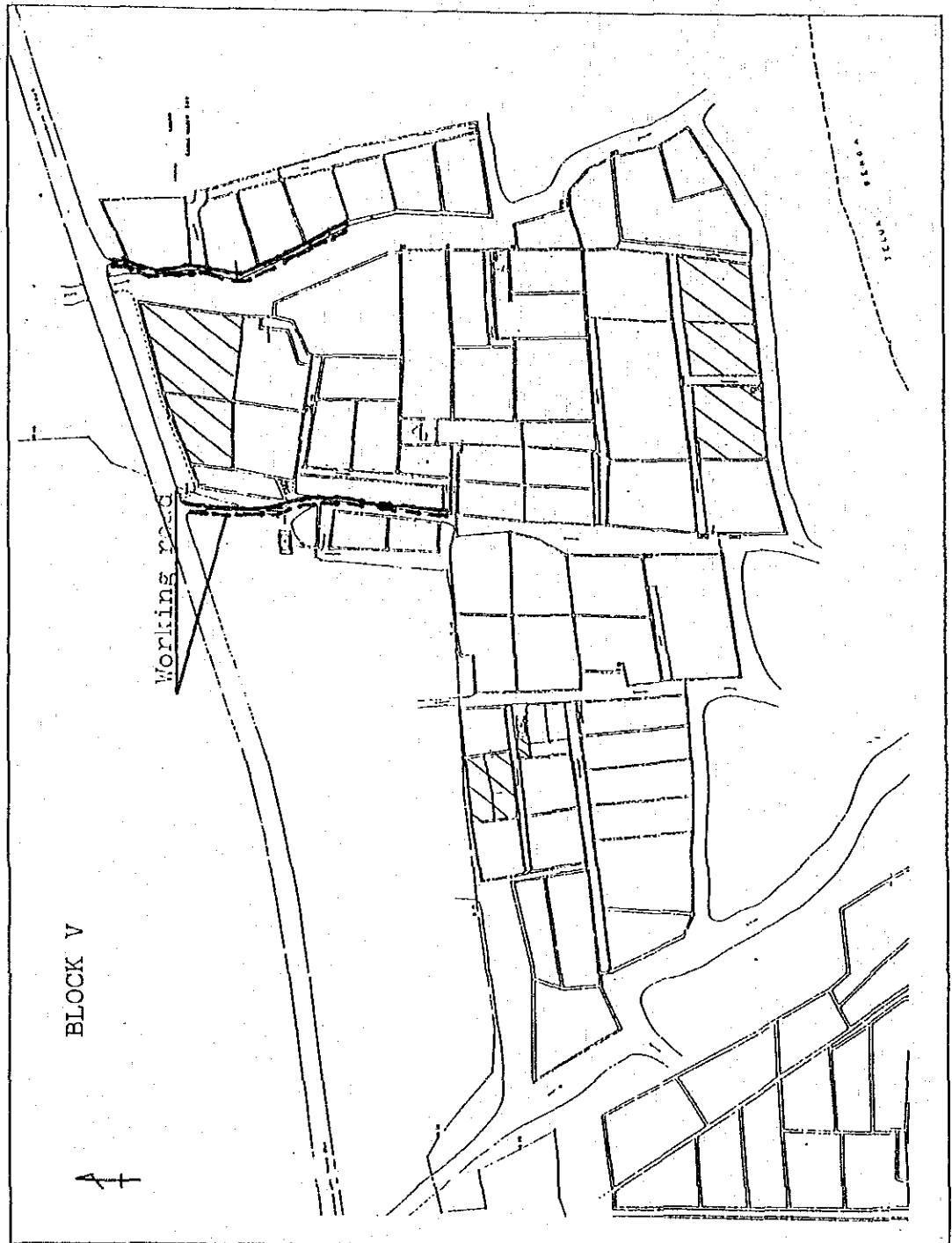


Fig. - 6 Working Road For Vehicle

2-7 Plan of forest roads

The plan of forest roads in the project site is as follows:

1) Access roads

The Center and the nursery will be constructed in Block II of national forest land. An access road will be constructed from the general public road to the Center through the national forest land. For this access way, the existing road will be repaired and a newly constructed section will be added. The total length of the access road will be 720 m of which 535 m will be repaired, 170 m newly constructed and 15 m bridged.

The structure of the access road is as follows:

- (a) The width shall be 4.0 m (Effective width , shoulder)
- (b) The surface of existing road will be roughly leveled and finished with gravel.
- (c) Both sides of the existing road being actually adjacent to the water channel, the slopes of 3 % gradient should be protected with stone masonry.
- (d) Since the newly constructed section of the access road is actually grass land and its base is not stable, it is necessary to lay earth on the ground in thickness of 40 to 50 cm.
- (e) The concrete bridge of 4.0 m in width and 15.0 m in length will be constructed to cross the channel.

2) Branch Roads

The existing road for Tambak will be used for operations of this project such as seedling transportation from the

nursery to the planting site, administration, surveys, etc. The total length of this road will be 4,180 m consisting of 1,160 m in Block II, 2,280 m in Block III, 440 m in Block IV and 300 m in Block V. This length is not sufficient. However, it is slightly difficult to construct newly a road for this project because the bank of the project site located in shrimp culture area is fairly destructed and that an opening is projected to be made in the bank in order to assure a smooth flow-in and flow-out of sea water in the planting site. But, a way that motorcycles can pass will be built as the afforestation works progress.

2-8 Plan for construction of footpaths used for the observation of natural forests

A fixed experimental area will be established in the natural forest around Tambak of Benoa Prapat national forest land in Bali and also in Gili Sulat natural forest in Lombok in order to carry out a survey on the ecology of Mangrove forest.

A fixed experimental area and fixed plots in the experimental area will be determined by an ecology expert and a short-stay expert of natural forest study according to the survey items to be executed in Bali and in Lombok. However, the natural forest in which a fixed experimental area will be established has been selected this time after the field investigation with an ecology expert.

The natural forest observation and study will be conducted mainly in Bali. It is therefore necessary to construct a wooden footpaths indispensable for the natural forest observation because data needs to be collected frequently.

(a) Block I

This Block is covered with a wide natural forest consisting mainly of Sonneratia sp. A wooden footpath of 122 m in total length will be constructed from the bank to the natural forest.

(b) Block II

Sonneratia sp. is extended in a form of green-belt and Rhizophoraceae spp. penetrates onto the side of Tambak. Two wooden footpaths of 70 m in length will be constructed with the space of 300 m and these paths will be connected to make it possible to walk around the Block.

(c) Block III

The Facility Area including the Center and the nursery will be surrounded with a demonstration forest. A wooden footpath allowing to observe the demonstration forest and the natural forest will be constructed with a length of 120 m.

2-9 Experiment plan

The experiments of this project is planned as follows:

1) Experiments in the nursery

The following experiments will be carried out through the nursing works in order to establish criteria of potted seedlings.

(a) Growth experiment

- To understand the relation between seed size and germination, establishment and growth.
- To examine the growth process of seedlings by species by means of sample seedling.
- To survey the growth situation of seedlings in provisional nursery.

(b) Nursing experiment

The experiments of submergence depth, salinity and shading will be conducted in the specific nursery to examine their influence on seedlings, and another seedlings will be planted in the planting site to grasp effects on the growth through the comparison with those grown in the ordinary nursery for industrial use.

2) Experiments in the planting site

The following experiments will be carried out through the planting works in order to systematize the afforestation techniques for the restoration of Mangrove forests.

(a) Growth measurement of planted trees

In the trial plantation site, seedlings will be planted by species according to their planting density and their provenance. A fixed plot (rectangular form of 20 m x 50 m (= 0.10 ha)) will be set in order to observe and measure every tree.

(1) Size measurement

- To examine regularly in the fixed plot the survival situation of seedlings from 2 months after the plantation.
- To measure the seedling/tree height, the clear length and the crown width every half a year and the stem diameter every year after the plantation. With regard to Rhizophora spp. it is necessary to measure the diameter of the stem at the point of approximately 30 cm above the joint of the highest supporting root.

(2) Examination of planting method

Based on the results of the survey on the survival and the growth process, it is necessary to examine planting methods including planting density, seed provenance, seedling species, etc. which will be suitable for production forests and/or protection forests.

(3) Water control

In the planting site of Bali, the growth process will be examined with the introduction of simple techniques such as flow-in and flow-out of sea water by natural tide through an opening created in the bank of Tambak and shallow ditches manually digged in the planting site for an easy drainage. The effects of these techniques will be estimated through the comparison with the results obtained from the existing afforestation site.

(b) Measurement of environmental factors

(1) Topographic measurement

The level surveying will be carried out in every point of the planting site to examine a flood tide level and grasp the sediment deposit rate and its influence on planted trees.

(2) Water environment monitoring

The change of the tide level will be measured and recorded by means of a stage recorder with data logger. A fixed type recorder will be installed near the Center in Bali and a portable recorder near the Lombok Island side of the afforestation project site.

The salinity and the pH value will be measured by sampling sea water at the fixed point near the nursery of Bali at full neap and spring tide in order to estimate the influence of dry and rainy seasons.

(3) Measurement of meteorological conditions

Meteorological instruments will be installed near the

Center in Bali and at the coastal side of the natural forest and the afforestation site in Lombok in order to measure and record the temperature, the precipitation and the humidity.

(c) Study on afforestation costs

Data regarding the project cost of Mangrove afforestation will be collected through different works of nursing and planting in order to calculate costs of each work process.

(d) Other experiments and surveys

(1) Experiment for plantation of big-sized seedlings

This experiment will be implemented on a small scale in sand tideland located at the outer side of natural forest in Benoa Bay of Bali. Since this area is beyond the range of Mangrove, big-sized seedlings will be introduced with a submergence depth more shallow to examine the possibility of forest development. Simple wave neutralizing methods such as piling, etc. will be also tested.

(2) Method of seedling transportation

The transportation of seedlings in Bali has no problem because the planting site is near the nursery. However, in Lombok, it will take approximately more than 3 hours to transport seedlings from the nursery to the planting site: 2.5 hours of land transportation by trucks and 40 minutes of marine transportation. For Lombok, seedlings with plastic cases in which they will be grown will be transported to the plantation site. With regard to the plantation in Lombok which is restricted by the longtime transportation from the nursery to the site and by the limited workable time due to

the tide, it is necessary to examine how to control seedlings and whether a provisional planting would be required or not.

3) Study on seeds

(a) Study on seed phenology

By selecting sample trees, the necessary time of phenological process: flower bud formation - flowering/seed bearing - seed maturing/seed dispersal will be examined in Bali.

(b) Study on seed production quantity

Seasonal tendency of fallen seed quantity and size maturity of fallen seeds will be examined by placing some seed traps. The seed production situation will be surveyed by selecting seed trees and by felling their surrounding trees. This survey will be carried out mainly in Bali, but in Lombok also to collect complementary data.

(c) Seed collecting

Seed collecting method and timing as well as transportation and stockage methods will be examined by species. The experiment will be carried out with regard to the acceleration of germination by species.

4) Experiment and study in natural forest

A fixed experimental area will be demarcated in Mangrove natural forest located in the coast of Benoa Bay of Bali Island and in Gili Sulat Island off the north-east of Lombok Island in order to study the ecology of Mangrove forest.

For this purpose, a fixed plot will be set in the fixed experimental area. The form of a plot depends on forest condition : transect type from the ocean side to the inland, massive type, etc. A square form has the size of approximately 100 m x 100 m (= 1 ha) and a transect type the width of approximately 20 to 40 m.

(a) Study of the environment in forest

Data will be collected by regular inspection in the fixed plots which will be executed mainly in Bali.

- Temperature, light environment, water environment, etc. by means of a data logger
- Sediment deposit evolution
- Litter deposit evolution by means of a litter trap

(b) Survey on stand evolution

The species, the diameter and the tree height of every tree within the fixed plot will be regularly recorded and the diameter growth and the shoot length will be regularly measured for sample trees by means of growth measuring bands, etc. in order to analyse the stand evolution.

This study will be executed mainly in Bali because frequent observations are necessary regarding the growth pattern. However, this study will be carried out also in Lombok with regard to the species which will need to be observed every 6 months.

(c) Survey on regeneration

The regeneration will be surveyed mainly in Bali in order to examine regeneration methods after felling of Mangrove forest.

- The fixed plot will be divided into some sub-plots in the size of 5 m x 5 m to 10 m x 10 m. In each sub-plot, the situation of regenerated saplings and their growth will be surveyed to analyse the relation with different environmental conditions.
- The felling of Mangrove forest (formed in square or in transect) will be carried out in accordance with relevant laws in order to examine later the possibility of natural regeneration or regeneration by sprout.
- This study will be also executed in Sumatra and Sulawesi for data completion.

5) Survey on fauna

The actual situation of wildlife will be surveyed in order to examine which kind of animals are harmful to planted trees during their growing stage, to anticipate potential pest insects and to collect the information for the protection and the conservation of Mangrove forests.

(a) Survey on fauna

Since it will take long time until the planted trees form a mature forest, the existing artificial and natural forests of Mangrove will be subject of the survey on change of animals and aquatic life in the afforestation site.

- Environmental conditions and change of fauna
- Change of fauna with the growth of planted trees

(b) Survey on pest insects

The survey on harmful insects and animals will be carried out in the plantation site, the existing artificial forest and natural forest.

- Situation of damaged trees and saplings
- Habitat, ecology and life history of harmful insects and animals
- Control method

6) Improvement of charcoal making techniques

The following studies will be implemented in order to establish standards of charcoal making process from the Mangrove wood harvesting to the charcoal making method.

(a) Charcoal making of Mangrove wood

Mangrove wood will be tested in order to examine whether it will be adequate as raw wood for charcoal making. Sample trees will be felled in the natural forest.

- Weight, volume change and quality according to the species and the diameter classes
- Actual situation of charcoal making in different regions of Indonesia

(b) Improvement of charcoal making techniques

Since the charcoal of Mangrove wood will be locally produced, it is necessary to examine the introduction of easy and effective techniques for charcoal making.

- Comparison of production efficiency of different charcoal kilns used in Southeast Asian countries

7) Analysis of socio-economic elements regarding the Mangrove afforestation

The study and analysis of the socio-economic effects by

Mangrove afforestation on local inhabitants will be implemented at the project site and in other places of Indonesia.

- Market structure analysis of regions where the charcoal making and charcoal consumption are observed
- Measures for participation of local inhabitants to the afforestation activities and their organization
- Analysis of influences produced by the afforestation activities on the living structure of local inhabitants
- Effects of the afforestation activities on fishery

8) Other items to be examined

The following items other than those above-mentioned from (1) to (7) will need to be examined:

- Formulation of manuals and picture books used to identify the species of Mangrove in Indonesia
- Formulation of manuals for the development and the conservation of Mangrove forest resources
- Setting of opportunities for exchange of views or joint research with Mangrove-related technical experts and researchers of foreign countries

3. IMPLEMENTATION DESIGN

Sufficient discussions with the concerned persons of the Republic of Indonesia and those in charge of the project have been done with respect to designing of roads, bridges, offices, nursery and related facilities. And the site survey, designing and estimation have been performed based on the results of these discussions.

3-1 Forest roads

The bridges for the access road and the road for exploitation have been designed.

1) Access Roads

(1) Selection of Route

Based on the viewpoint of the mission for Record of Discussions (R/D) dispatched from October to November 1992, the routes shall pass through the national forest land. From the public road to the site of the Center or other buildings, the existing driveway in Tambak is to be repaired and used, and new road is planned where there is no existing road.

(2) Survey of Route

(a) Survey of the Center Line

The center lines of the forest road have been surveyed with a surveying compass with transiting telescope.

(b) Longitudinal Leveling

As there is no existing reference point, longitudinal leveling have been carried out supposing the surface of the public road's junction as a bench mark of 10m height. Measuring the height of each survey point of the central line, and those of the starting point and the terminal point of the route, the height of the ground has been calculated.

(c) Cross Leveling

The cross leveling has been carried out with a pole 2m long, at each survey point of the central line and at the plus stake at a right angle with the central line. The leveling width was 5m measured horizontally from the right to the left.

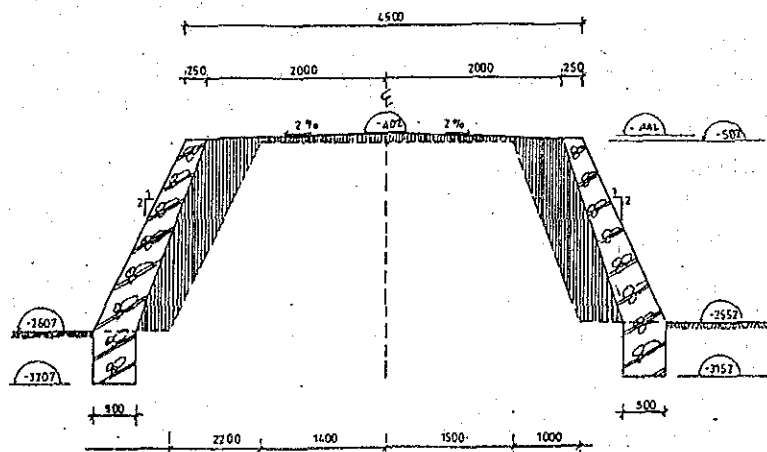
(3) Designing

(a) Specifications

To prevent accidents like falling, the speed limit of vehicles shall be 20km/h. The effective width of the road will be 3m, and the shoulder on each side will be 0.5m wide each. Masonry being applied to the face of slope, the gradient of the banking's face of slope will be 1:0.3.

(b) Roadway Diagram

The standard roadway diagram is as shown below.



(c) Design of Bridges

As a result of site research and survey, it was decided to design the bridges of access road with the span of 15m and that of road for exploitation with the span of 10m. As the bridges in Indonesia must be designed based on the design standards of PU (Indonesia's Ministry of Public Works), these bridges are designed in conformity to the standards. The economy in designing and the term of works in Indonesia depends on how much of the materials used are procurable in Indonesia. Taking this into account, we designed the bridges with the materials which are all available in Indonesia, from cement to components. The structure is designed to be a composite type (combination of steelwork beams and concrete slab) to decrease the load on the pedestal as much as possible and to reduce the cost of foundation works because compared with the precast beams or the prestressed beams, this type is lighter in the dead weight. In Indonesia, a composite type is mainly applied to the foundation of bridges on the weak ground. The advantage of the composite type is that the foundation and the bridge part are separated; the bridge will not be cracked even if the secular ground subsidence should be caused because the beam part will absorb the subsidence to some degree.

The condition for designing was that a 2 ton truck with the allowable live load of 2 tons can run safely on the bridges. As the safety rate of bridges is prescribed as "3" in the design standards of PU, the safety rate "3" was applied to the structural calculation too.

2) Branch roads

In this plan, only bridge with the span of 10m has been designed. (Refer to "Bridge of Access Road".)

3-2 Footpaths for the Observation of Natural Forest

A fixed experimental area will be set in the natural forest in the neighborhood of Tambak in Bali's Benoa project site, to carry out researches mainly on Mangrove forest. As it is necessary to collect data frequently in this fixed experimental area, it was decided to construct wooden footpaths for the observation of the natural forest. The design points of the footpaths are as follows:

(a) Block I

The timber road over the water channel (20m) must be above the maximum tide level, and beyond the channel a simple wooden footpaths with three coconut trees of 30cm diameter put side by side will be constructed. The wooden footpath and the simple wooden footpath will be connected with stairs. The total length of the footpaths will be 122m.

(b) Block II

Two wooden footpaths 70m long and above the maximum tide level will be constructed. The distance between the two footpaths will be 300m and these will be connected with a simple wooden footpath with three coconut trees of 30cm diameter put side by side. The total length of the footpath will be 442m.

(c) Block III

A wooden footpath above the maximum tide level (20m) will be constructed to make it possible to observe and inspect the demonstration forest and the natural forest. The footpath will be further extended and the total length will be 120m.

3-3 Buildings and Related Facilities

1) Conception for Designing

For the designing of the center building, we studied the possibility of reducing the size of the center office and of using, during the project period, the office in the Balai RLKT site used currently by the project side as a temporary office. As a result of discussions with the project side, however, it was found out that the project side is in earnest need of a single office for the management and operation of this demonstration research. It was, therefore, decided to design the center based on the viewpoint of the mission for Record of Discussions.

2) Layout

The location of the center office decided upon as a result of discussions with the concerned persons of the Republic of Indonesia and the project side, is as shown in the layout.

3) Sizes of Facilities

The sizes of facilities are as follows:

(1) Office 413m²

Office Room	147m ²
Conference Room	26m ²
Materials Room	86m ²
Shower Room and Toilet	44m ²
Others	110m ²
(Waiting Room of Drivers, Porch, Storeroom, and Pantry)	

As the buildings in the Bali Province are not allowed to construct by the ordinance of the Province Government unless they are designed in the Bali style (especially the porch and the roof), we got the design drawings of one-story houses under construction in Bali and fully relied on the drawings for designing.

Name of the Ordinance

Lembaran Daerah
Propinsi Daerah Tingkat 1 Bali
Tahun 1977

Peraturan Daerah Propinsi Daerah Tingkat 1
Bali

Tentang:

1. Tata Ruang Untuk Pembangunan.
2. Lingkungan Khusus.
3. Bangun - Bangunan.

Dihimpun Oleh
Biro Hukum Dan Organisasi & Tatalaksana
Kantor Gubernur Kepala Daerah Tingkat 1
Bali

(2) Laboratory Building 96m²

As the laboratory building must also be of the Bali style like the office, we fully relied on the design drawings of buildings under construction in Bali.

(3) Garage and Storage 84m²

We got the design drawings of the garage which our counterpart organization in Bali (BRLKT) owns and referred to them in designing the garage. Concrete is to be placed all over the floor of the garage.

(4) Generator Room 30m²

It is possible to lead public power in with 750m wiring (electric poles and wires) from the public line, but according to our finding in field surveys, the public power supply is currently at the limit of its capacity and new application will not be accepted until 1994. We judged it, therefore, impossible to lead public power in.

Accordingly, we have decided to apply a 32.5KVA generator to day use and a 15KVA generator to night lighting. We designed plug sockets, circuits and others taking into consideration the future supply of public power. In designing the generator room, we referred to the design of the garage.

(5) Potting House 114m²

In designing the work cabin, we referred to the design drawings of the garage. We designed the floor to be concrete slab.

(6) Water Tank 558m³

We made interviewings on the wells used in private houses in the neighborhood of the project site. We judged the water of the wells unsanitary because every well is about 4m deep and it is feared waste water of everyday life is permeated in it. We further found out the hotels in the neighborhood and obtained varied results. As a result of it, we judged that a well must be at least 30m deep. A water tank is to be installed 3m above the ground.

(7) Entrance Gatehouse 6.25m²

As the entrance gatehouse is located at the front of the project site, we designed the house to be of the Bali style.

3-4 Nursery

To promote the trial plantation activities of this project and to establish the reforestation techniques of production forests on an industrial scale, it was decided to establish a nursery stable for a long time. The design points of the nursery are as follows:

1) Sizes of the Nursery

The area of the nursery for industrial use was decided to be 4,974m² taking into account the number of required beds, the paths for working, footpaths, and the production of big-sized seedlings to afforest the outer sandy soil (sand deposits of the natural forest). The number of beds was decided to be 204. The area of the testing nursery was decided to be 547m².