

51-90

REPORT OF FEASIBILITY STUDY
FOR
REFORESTATION COOPERATION PROJECT
IN
MADANG AREA, PAPUA NEW GUINEA

FEBRUARY 1977

206
883
FDD

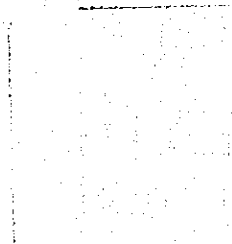
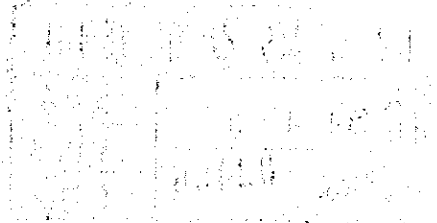
JAPAN INTERNATIONAL COOPERATION AGENCY

77

JICA LIBRARY



1043284[7]



国際協力事業団	
受入 月日 '84. 4. - 3	206
登録No. 02456	88.3
	FDD

TABLE OF CONTENTS

	PAGE
I PURPOSE OF THE STUDY	1
II MEMBERS OF THE STUDY TEAM	2
III RESULT OF THE STUDY	3
1 Outline of Reforestation Plan	3
1-1 Basic concept	3
1-2 Reforestation	3
1-3 Infrastructure	17
2 Implementation of the Project	18
3 Cooperation on Government-to-Government Basis	20
3-1 Technical cooperation	20
3-2 Exchange of views	21
APPENDIX I PNG GOVERNMENT OFFICIALS COOPERATING THE .. STUDY	22
APPENDIX II MISSION'S ITINERARY	23
APPENDIX III INTERIM REPORT	26

I PURPOSE OF THE STUDY

This feasibility study for the reforestation project in the Madang area of Papua New Guinea (referred to as PNG hereafter) is the follow-up of the pre-feasibility study which was conducted July and August, 1975, at the formal request of PNG government to the Japanese government in September, 1974.

Previous mission of the pre-feasibility study reported basic guidelines for the project, some basic ideas for the implementation of the project such as implementing body and technical problems such as method of reforestation, after exchanging views with PNG government authorities and the field survey in the proposed project area.

The purpose of this feasibility study is to make a reforestation plan on the area and to find out the effective means to implement the reforestation project through exchanging views with PNG government authorities and a fairly intensive field survey in the proposed reforestation area.

II MEMBERS OF THE STUDY TEAM

The team was composed of the following nine members, headed by Mr. Shoichi Fukuda, former Director General of the Forestry Agency, Government of Japan. The study was conducted from April 19, 1976 to May 22.

- FUKUDA, Shoichi : President, Forest Development Corporation
- JINGUJI, Mamoru : Executive Director, Forest Policy Research Institute
- HACHIYA, Kinji : Head, Silviculture Division, Government Forest
Experiment Station
- SAKAGAWA, Shoki : Assistant Chief, Hokkaido Branch, Forest Engineering
Consultants
- HAYASHI, Ryoji : Senior Officer, Forestry Agency, Ministry of
Agriculture and Forestry
- KAWAMURA, Kazuo : Head, Financial Cooperation Division, Forestry
Development Department, JICA
- OKADA, Katsusuke : Chief, Survey Unit, Planning Division, Forestry Agency
- YAMADA, Rintaro : Head, Silviculture Division, Hokkaido Reforestation
Association
- UESUGI, Takashi : Deputy Head, Development Division, Forestry
Development Department, JICA

III RESULT OF THE STUDY

1 Outline of Reforestation Plan

1-1 Basic Concept

Planning of a reforestation project should be closely related with the rural development programme of the area, the PNG government expects that reforestation would be a core of the socio-economic development.

The project should be prepared with due regard to the balanced and steady development, both economic and social, of Madang area.

The economic development will be achieved through the industrial development which would introduce wood chip manufacturing and saw mill and would consequently establish an integrated forest products industry complex including large-scale saw and plywood mills, it will be also achieved through the reforestation development of Gogol/Naru areas which would transform natural forests into highly productive plantation as potential source of materials.

The social development will be achieved through the human development by means of training and extensive of techniques for local population, and through the environmental development such as the establishment of a base camp for reforestation.

1-2 Reforestation

(1) Pre-condition of planning

The exploitation of existing natural forest in Gogol and Naru areas will be carried out by JANT after deliberate consultation with the Department of Forests, PNG government on the area and volume of the exploitation.

Most of the timber produced from the plantation will be used for wood-chip for pulping, some suitable timber could be used for sawn lumber or plywood after the construction of necessary facilities, training of personnel and securing of the market, all those being done by the private sector.

The reforestation will be planned considering, first of all, silvicultural problems, the requirements of the Land Use Plan authorized in "Scenario 3B" by the PNG government and the progress of JANT operation.

(2) Reforestation site

Determining factors for the selection of the reforestation site would be micro-climate, topography, soil, plant vegetation and other influential environment. In selecting a appropriate plantation site, it should be done in close relation with selection of proper planting species.

The selection was done in the following manner. About 8,000 hectares with 14 blocks were picked up as prospective reforestation sites after due consideration of various topographic factors. These areas were mapped on the scale of 1 : 5,000 and the relationship between topography and forest features of the areas were analysed.

The field survey over these areas gave more detailed informations on soil conditions, whose relationship with topography and forest features were also studied.

Then a basic standard of reforestation site selection was established and its result was shown on the map on the scale of 1 : 5,000.

The map of potential reforestation site in Gogol/Naru areas was made on the scale of 1 : 25,000 by extending the characteristic tendency of above-mentioned study.

Through the field survey it was found out that the local drainage would be one of the most influential factor, for the selection of reforestation site, while the flat terrain would be the most suitable site.

Thus the identification of local drainage, swamp, water-logged or wet land, would be necessary, for accurate determination of the site. The drainage in flat terrain will be able to be identified by surrounding topographic features like adjoining the bank of river, and by arboreal vegetation on the stand like appearance of small-canopy and low-height hygrophilous species in swamp and bog land.

According to the field soil survey, drainage will be also easily identified through the study of various characteristics of soil such as the color of surface soil, existence of brownish spot of iron oxide, or depth of gray soil layer.

The intensive soil survey over the whole area would be needed for implementation of large-scale reforestation.

In this study the following four categories of sites are established according to the suitability of reforestation which would be mainly composed of fast-growing species for wood-chip.

- (A) First Class Reforestation Site
- (B) Second Class Reforestation Site
- (C) Third Class Reforestation Site
- (D) Non-reforestation Site

First Class Reforestation Site (A) is wet, flat and low terrain with deep soil layer which is the most suitable reforestation site for fast-growing hardwood species.

Second Class Reforestation Site (B) is divided into three sub-categories. The first one (B₁) is water-logged low land suitable for plantation of hydrophilous species if planted while the land is drained. The second one (B₂) is hill slope side, of which concave slope with deep soil would be suitable enough for fast-growing species reforestation and convex slope with no deep soil would be only suitable for xerophilous species which could grow under poor nutrient condition. The third sub-category (B₃) is the hill slope with 11° to 15° degrees with complicated topographic features and shallow soil, where only the reforestation of xerophilous species will be possible.

Third Class Reforestation Site (C) is the hill slope with 15° to 20° degrees and water-logged terrain inside mountainous area, where large-scale reforestation would be very difficult although some small-scale reforestation could be considered.

Non-reforestation Site (D) is the swamp, steep slope and flood area where reforestation is impossible.

The above-mentioned explanation is summarized in the following Table 1.

TABLE 1 TOPOGRAPHIC TYPES AND REFORESTATION

<u>Topographic Type</u>	<u>Slope</u>	<u>Reforestation Site</u>	<u>Remarks</u>
<u>Hilly Area</u>			
Hilltop	2° - 6°	D	No reforestation
	1° - 2°	B2	Downhill with deep soil: good for reforestation. Upper and convex hillside: good for Accasia spp.
Hillslope	3°	B3	Suitable for xerophilous species like Accasia spp. and Pinus app.
	4°	C	Partially suitable for reforestation
	5° - 6°	D	No reforestation
Swamp	0° - 2°	D	No reforestation
Water-logged	0° - 2°	C	Partially possible for reforestation of hydrophilous species
<u>Flat Lowland Area</u>			
Swamp	0° - 2°	D	No reforestation
Water-logged	0° - 2°	B1	Suitable for hydrophilous species planting in dry season
Moderate Wetland	0° - 3°	A	Good for large-scale reforestation of fast growing species
<u>Fluvial Area</u>			
Riverside Slope	3° - 5°	D	No reforestation
Food Land	0° - 1°	D	No reforestation
	2° - 3°	C	Partially good for reforestation depending on drainage conditions
Bar	0° - 2°	D	No reforestation
Riverbed	0° - 1°	D	No reforestation

Figure 1

Reforestation Site Map I

(Scale 1 : 5,000)

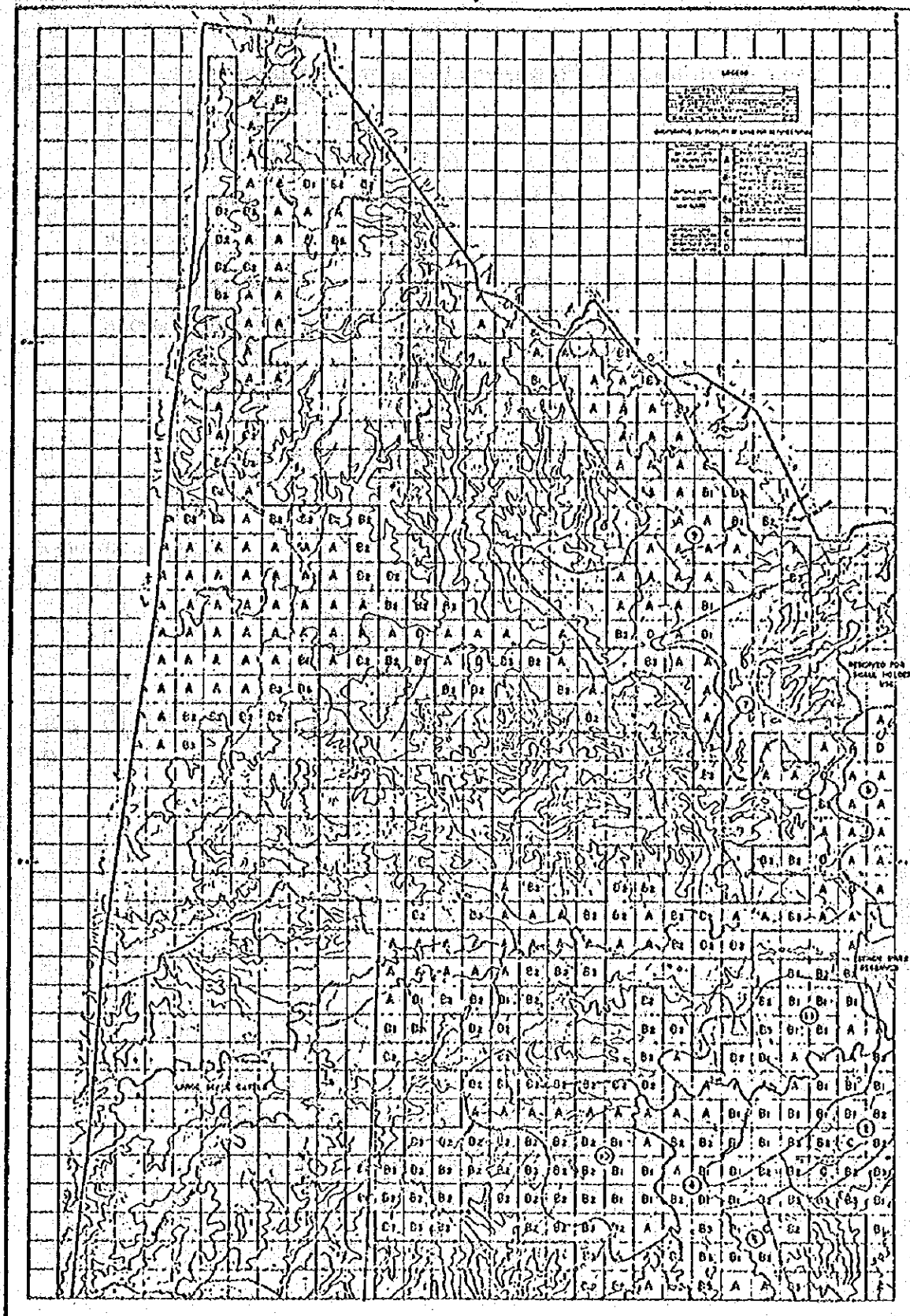


1:5,000

Figure 2

Reforestation Site Map II

(Scale 1 : 25,000)



1:25,000

Figure 1 is an example of reforestation suitability map on the scale of 1 : 5,000 with application of table 1.

Figure 2 is an example of reforestation suitability map on the scale of 1 : 25,000.

Table 2 shows some estimation of reforestation in Gogol/Naru area by each category. Land for villages agricultural uses, protection forest for watershed, road and so on should be excluded from these figures.

Then appropriate reforestation area would be about 20,000 hectares which is about 70% of total area.

Table 2

Estimate of Reforestation Area by Categories

Reforestation Site	Hectars () percent		
	Gogol	Naru	Total
A	5,100 (41)	2,500 (29)	7,600 (36)
B ₁	2,000 (16)	4,800 (55)	6,800 (32)
B ₂	4,200 (34)	1,000 (11)	5,200 (25)
B ₃	1,200 (9)	400 (5)	1,600 (7)
Total	12,500 (100)	8,700 (100)	21,200 (100)

(3) Species for reforestation

Planting species for reforestation in this project was chosen mainly for wood-chip production for the time being and determined from the following criteria.

- a) Fast-growing species which are expected for harvest of about 10 years old and which are suitable for wood-chip.
- b) Species which have already tried plantings in tropical lowland rain forest region and which would be expected good growth in the proposed reforestation area.
- c) Species of which the specific silvicultural techniques are assumed to have been established.
- d) Species of which the supply of seed or seedling is available.
- e) Species which are strong against insects and diseases.

Few species would be entirely satisfactory at present time in view of these criteria pre-requisite for implementation of large-scale reforestation, enough silvicultural experiment has not been tried in the lowland rain forest region.

After field survey and study of available informations, however, the following six species are picked up for the coming reforestation.

Eucalyptus deglupta

Albizia falcata

Gmelina arborea

Eucalyptus tereticornis

Terminalia brassii

Acacia aunculaeformis

First three species are the fast-growing ones, suitable for reforestation in moderately wet area with deep soil. Second two species are suitable species with fairly good growth for reforestation in water-logged area with poor drainage. The last species, *Acacia aunculaeformis* is good for reforestation in comparatively dry convex hillslope.

It would be rather desirable for large-scale reforestation to have as many planting species as possible suitable for various kinds of site conditions.

Possible fast-growing species, which have been extensively planted in tropical lowland rain forest region in other Oceanic Area and will have high possibility of success in reforestation in PNG, would be the following;

Eucalyptus camaldulensis

Eucalyptus citriodora

Terminalia calamansanai

Camptosperma brevipetiolata

The trial plantings of these species should be carried out at the same time.

It would be necessary for large-scale future reforestation the trial plantings of the following species at the earliest possible time in order to select the most suitable species in the right site for the right purpose.

- a) Tropical pine species which would be suitable for plantation in mountainous area of Gogol and Naru, plantation of *Pinus caribaea* and other tropical pine species have been practiced in many areas of tropical lowland rain forest region, including the Bulolo area in PNG situated 700 meters above sea level.
 - b) Suitable species for lowland flat water-logged site, this type of site in the proposed reforestation area being huge.
 - c) Species which would be used for sawn timber or plywood production.
 - d) Species for enrichment planting after selection cutting.
- (4) Target of reforestation area by species

Final target reforestation area by species is assumed as in the following Table 3 after deliberate consideration of planting species, planting density, planting method and harvest age by different site conditions.

Table 3

Final Target Reforestation Area by Species (hectars)

Species	Gogol	Naru	Total
<i>E. deglupta</i>	3,500	2,500	6,000
<i>E. tereticornis</i>	2,000	2,500	4,500
<i>A. fulcata</i>	2,500	500	3,000
<i>G. arborea</i>	1,000	500	1,500
<i>T. brassii</i>	-	2,000	2,000
<i>A. aureculaeformis</i>	2,500	500	3,000
Total	11,500	8,500	20,000

The silvicultural management system will be the combination of types of land preparation, planting method and planting density as in the following:

- a) Two types of land preparation and planting method
 - o Clear slashing/cutting and conversion planting
 - o Strip slashing/cutting and line planting
- b) Three types of planting seedling density
 - o Dense ; 1,100 seedlings per hectar

- o Medium ; 625 seedlings per hectar
- o Sparse ; 417 seedlings per hectar

Reforestation would be started from the fairly flat and easily accessible lowland area with simple environment conditions.

50 percent of Naru area would be assigned for reforestation, which will be divided into two sub-areas. One would be the demonstration reforestation of fewer species but large scale. Another would be the reforestation of various management system of many species.

About 25 percent of Gogol area would be assigned for reforestation which will be smaller than Naru area, because Gogol area has more complicated topographic conditions like narrow hill ranges and small valleys which give influences to micro-environmental factors, and will need many varieties of planting species.

Annual reforestation area of coming three years would be about 800 hectars, considering from land availability for reforestation and progress of silvicultural techniques.

(5) Nursery

Two nurseries of about ten hectars, which will include seed orchard and demonstration tree garden, would be established one each in the Gogol and the Naru areas, taking account of such elements as the location of the proposed reforestation area, planting species, the silvicultural arrangement system and accessibility to the plantation site.

At the final stage each nursery is expected to produce constantly about 1,500,000 to 1,600,000 seedlings per year, which will be enough for implementation of the reforestation plan.

(6) Supply of seed

Seeds of the proposed planting species would be mainly supplied from the PNG governmental agency.

There is a big difference of growth in tropical fast-growing species which comes from variance of mother trees or producing places, and even the insufficient selection of seed from the same mother tree may cause big different growth of trees in stand.

The PNG governmental agency is promoting the selection of excellent elite tree, and the establishment of seed orchard and provenance test in accordance with the intensive tree improvement plan as far as *Eucalyptus deglupta* is concerned. It is highly recommended to take the same kind of measures on other prospective species.

Since it is desirable to produce excellent quality seeds produced under the same environmental conditions as that of the plantation, the establishment of a seed orchard near by the nursery and the collection of seeds from a well-managed plantation will be urgently needed.

In view of the fact that the fresher seeds are better for planting it is necessary to stock a certain amount of seeds all the time preparing for the time lag between seed collecting and sowing or yearly difference of seed production.

Proposed species for the reforestation except *Terminalia* have no typical yearly difference of seed production, and the stock of their seeds is fairly easy at the temperature of 5 to 10 degrees centigrade and under air-free condition. Stocking technique of *Terminalia* seeds has not been developed enough since it loses vitality rapidly after collecting and the germination rate of better seeds at the time of 2 months after collecting is below 50 percent.

The ordinary refrigerator would be enough for stocking small-seeds like *Eucalyptus*, but for big seeds like *Acacia*, *Terminalia* and *Albizzia*, bigger refrigerator with low temperature would be required.

(7) Nursery technique

Improvement of techniques applied to pot-seedling and transplanting would be important for large-scale seedling production and efficiency of work.

Seedling of 30 cm high and 5 mm root diameter with healthy branches is better for planting in order to make the initial growth rate faster, while the present standard of planting seedlings is to use the one with the height of about 25 cm after 3 to 4 months nursery period. For this purpose, the number of potted seedling per square meter in the nursery should be 100 to 120 rather than the present number of 150 in Gogol area.

It would be necessary in nursery practice to make the supply of water well controlled in accordance with growth of seedlings since soil moisture could control the growth.

As there are few skilled local laborers in nurseries at present, training and maintaining the fixed number of nursery laborers would be very much important.

(8) Land preparation for planting

Land preparation for planting can be divided into two types; clear slashing/cutting and strip slashing/cutting.

Work efficiency of clear slashing/cutting may differ by the quantity of left trees after cut-over and the conditions of underlayer plant vegetation. An example of JANT's present reforestation in Gogol area shows that man powers needed for clear slashing/cutting are about 20 men-day per hectare at the time of 9 months after cut-over and about 35 men-day per hectare one year after cut-over, while, in comparison with man powers, needed at the time of one year after cut-over, only half of man powers would be enough immediately after cut over, this comes from the fact that growth of underlayer vegetation and vine-trees is enormously fast in tropical region.

Bulldozer would be a more useful and efficient equipment for land preparation on a gentle sloping ground with comparatively smaller shrubs and stumps than such ordinary equipments as chain-saw, brush-cutter and bush-knife.

Firing as a measure of land preparation for planting would be dangerous one in case carried out by poorly trained laborers and sometimes would cause difficulties in such humid area in Gogol/Naru, but could be useful in case carried out at limited sites in forest land with huge amounts of bushes and branches on the surface.

Use of herbicide would be one of the seriously considered matters from the viewpoint of forest conservation and ecological balance although it has been practised in tropical forests for treatment of remaining trees after cut-over.

Treatment of remaining trees after cut-over with a scale of diameter under 20 cm or trees of bad shape in lowland forest would be one of the

problems to be resolved for land preparation; If these trees will remain, they would surpress newly planted trees. If these trees will be crashed down by trunk circular treatment (girdling), this would also cause damages to newly planted trees.

In view of these facts, a basic measure to be adopted for land preparation in the case of square planting would be, in principle, clear slashing/cutting.

Strip slashing/cutting is an effective and popular method for land preparation in tropical region on the ground that it alleviates planting. However, not a few plantations, even through applying this method fall in their management owing to insufficient after-cares of tending after planting.

In this plan, the strip slashing/cutting of 4 m width at interval of 4 m width and the line planting at spacing of 3 m within stripped zone would be used for reforestation of *Eucalyptus deglupta*, *E. tereticornis* and *Acacia auriculaeformis*. Standing trees above 5 m height in residual zones would be treated by girdling or felling.

This planting method would cost about 40 percents less than the method of clear slashing/cutting and conversion planting.

(9) Planting

The best season for tree planting in this area would be rain season that is, November to February. It would be appropriate, however, for a large-scale reforestation to keep planting even in dry season, that is, March to May, on water-logged sites or bog land for the purpose of acquiring as much opportunities as possible for planting.

Owing to micro-topographic condition, soil characteristics or miscarriage of land preparation, some part of expected reforestation site would become unsuitable areas for originally-designated species. In this case the proper species for planting should be found out and be planted promptly.

Planting of potted seedling, should be done right time in right place. Even so, it may cause the group withering which would need the replanting at the time of first tending treatment after planting.

(10) Other treatments in tropical silviculture

Struggle for survival of planted trees against weeds, bushes or unwanted natural trees should be well-controlled to achieve a successful reforestation in tropical region.

For this, tending treatments to protect plantation should be done 6 times in the first year after planting and 3 times in the second year in principle. In the case of square planting, in principle, clear weeding should be practiced, and at the second year, in addition to the clear weeding strip weeding also be carried out according to the conditions of planted trees. Removal of vine trees would be also necessary since full coverage of forest land by harmful vine trees would give great minus impacts on the growth of planted trees.

It would be important to review management types of planting tree density since it has close relationship with tending after planting such as slashing, cutting of unwanted trees or removal of vine trees and then with reforestation costs.

As far as fertilization is concerned effects of fertilization are not so eminent in the proposed reforestation area since most of the area belongs to alluvial soil area of flat lowland. At present the results obtained from the fertilization experiments do not meet the expected requirement and the establishment of technical standard for forest fertilization in tropics is needed by practicing further experiments.

Thinning and pruning would not be necessary since the present reforestation is aimed at wood-chip production. Fast-growing planting species in tropics are intolerant in general. This fact means that oppressed and inferior tree would be withered naturally and no silvicultural thinning would be needed on its plantation.

(11) Protection of plantation

The combination of planting of various species in the reforestation area would be desirable in order to minimize the attacks of unpredictable harmful insects or diseases and to protect plantations against damages caused by them. From the same viewpoint the shelter belt forest by natural stand should be

established between plantations, and on riverside, hilltop, steep hillslope, watershed areas or roadsides. The shelter belt forest will not only protect plantations against attacks of insects, diseases and fires but also work for erosion control and watershed.

The establishment of the complete road network system and the communication system, as well as full preparation of enough equipments and facilities for protection against insects, diseases and fires would be necessary for achieving satisfactory management and administration of reforestation. These systems will discover damages immediately after attacks and protect the plantations.

1-3 Infrastructure

(1) Forest road

Existing forest roads for logging could be used for the reforestation. The maintenance and administration of them will be performed paying the due consideration to the convenience of local people in the area. No further expansion of road would be needed for the time being.

(2) Other infrastructures to be established

It would be desirable for efficient management of the reforestation as well as for well-being of local people in the area to establish such necessary facilities as base camps, a technical training center, communication complexes and meteorological and silvicultural observation posts, etc..

The base camp with a view to securing the necessary technical stuffs and workers will include people's well-being facilities such as housings, water supply, facilities, a medical office, a market and a assembly hall, and at the same time, such reforestation's facilities as a warehouse, a repair shop and a power station will also be included. This kind of base camps will be set up one each at Gogol and Naru areas.

The technical training center, in addition to diffusion of forestry knowledge and training of the local people, could also be used for training the core experts in the plantation as well as the government employees or college students by afforesting opportunities to experience field activities, which will develop their professional technologies.

The communication facilities are important for achieving the efficient management of forestry and the better-living of people. They will make the prompt and close communications among operation areas and local communities.

Facilities for collecting of meteorological or silvicultural information are also important for the implementation of the reforestation project. Since the project is in nature, the pioneer project in tropical region and the available observation data are not satisfactorily sufficient for scientific analysis and management determination. Such informations and data as temperatures, rainfall or growth of planted trees should be observed and collected periodically, permanently and systemitically.

2 Implementation of the Project

Since the reforestation project takes a long time from reforestation or afforestation to a harvest, and during the growth period it may be affected by such unpredictable factors as damage by insects, diseases or fire, the investment in a reforestation project would be very risky and insecure, and the adequate returns could not be guaranteed.

For the successful implementation of the reforestation project, it would be necessary for any country not only to resolve the whole technical problems and clarify legal matters involved such as land tenure and right of cutting timber, but also to establish financial schemes giving much incentive to reforestation such as a soft loan, tax concessions or an insurance guarantee system.

It is understood that there still exist many difficulties for implementation of the reforestation project carried out by a private enterprise. It is desirable that both governments of PNG and Japan should make their endeavors and cooperate actively to realize the reforestation project under the present system with certain supplementations.

The following matters should be considered specially important and be resolved.

(1) Security of tenure

In the proposed reforestation sites in Madang area, land is customary owned jointly by the local people. According to the land policy of the PNG

government, the land to be used for the reforestation should be leased from the land owners to the PNG government and then sub-leased from the government to executing body of the reforestation.

Everything on stand including growing timber belongs to the land owner according to the legal system of PNG. From this background executing body has to secure the right to use leased land for reforestation and to dispose of his planted tree, in the sub-lease agreement. The executing body has further to proceed the registration which guarantee indefeasible claims against the third person.

Legal effectiveness of the land lease agreement between the land owners and the PNG government would be judged on a case-by-case basis and this formula has not establishment according to the opinion of judicial office in the PNG government.

(2) Participation by people living in the proposed reforestation area

Establishment of a strong public relations program would be of considerable importance so that the local people may understand the fact that the reforestation would contribute not only to their own welfare but also to the socio-economic development of the area. The promotion of their understanding would also be useful to solving the land lease problem, promoting their shareholding of the reforestation company, and to getting their cooperation in protecting the plantations from fire or other damages.

(3) Incentive schemes for reforestation

In promoting the reforestation project the returns on its capital should be secured, and in this contest, the establishment of the insurance system be recommended. Since the insurance system, is based upon a law of great numbers in calculating of insurance premium and available information on it are limited in PNG. It would be considered very much difficult in PNG to establish the forest insurance system.

And in connection with the insurance system, the establishment of accident compensation system sponsored by the government is also recommended, but can be found many difficulties in PNG.

It would be necessary, therefore, for the implementation of large-scale reforestation projects by private enterprises to make up the overall policy of the PNG government including the policy on a debt guarantee system such as a reforestation fund and on a concessional taxation concerning reforestation investments.

By way of conclusion, the implementation of this reforestation project would be better to be carried out by the newly established reforestation company which the previous survey report had mentioned, with financial and technical supports of JICA and with strong back-up of PNG government which would lead to the local people's participation into the reforestation company, security of land for reforestation and realization of new schemes giving much incentive to the reforestation project.

3 Cooperation on Government-to-Government Basis

3-1 Technical Cooperation

From the PNG government the study team has received a list of interested fields for technical cooperation and aid, at the governmental level in order to support and assist the reforestation project in the Madang area. The contents of the list are as follows:

- (1) Nursery techniques in soil sterilization; automatic plant container filling; watering and fertilizing systems; plant container systems.
- (2) Nutrition studies in the reforestation area with particular emphasis on analysis of existing soil fertility levels in the biomass, and on the subsequent effect of logging and successive forest plantations which may lead to declining levels of soil fertility.
- (3) Alternate logging methods and of different extraction machinery to minimize damage to the soil and other matters of concern. This aspect could be considered in conjunction with various forest management practices e. g. variation in selective logging.
- (4) The examination of available machinery that could be used for site preparation prior to planting, e. g. machines that would slash and/or crush secondary growth, and possibly others that could plough mounds to provide planting sites.

(5) Field classrooms, accommodation and other facilities at Gogol for use of students from the Forestry College and the University of Technology during practical training exercises.

(6) Extension to the Forestry College, Bulolo, of wood technology and botany laboratories.

These requested fields should be reviewed to distinguish carefully between the private-based technical experiment which could be done along with the progress of the reforestation project and the government-based technical cooperation which would be in principle carried out in basic science field.

3-2 Exchange of Views

There was a suggestion at the time of the previous survey as well as this time that an exchange of views on this project at the governmental level would be useful since large-scale reforestation projects in tropical region are in nature, pioneer projects and have many technical and organizational problems to be resolved for successful implementation of the project.

APPENDIX I

PNG GOVERNMENT OFFICIALS COOPERATING THE SURVEY

(PORT MORESBY)

Mr. JOE AUNA	Director, Department of Forests
Mr. K. WHITE	First Assistant Director, Department of Forests
Mr. J. GARDNER	First Assistant Director, Department of Forests
Mr. A. YAUIEB	Department of Forests
Mr. C. HIGHAM	Department of Forests
Mr. J. TAKAPAN	Department of Forests
Mr. G. BELL	Department of Forests
Mr. I. WHYTE	Department of Forests
Mr. A. ROSS	Department of Forests
Mr. I. N. WHITE	Department of Forests
Mr. G. WYLIE	Department of Justice
Mr. K. PALHER	Department of Finance
Mr. W. P. KANAWI	NIDA
Mr. P. EDDOWES	Project Officer, Forest Product Research Center

(MADANG TIMBER COMMITTEE)

Mr. J. NALAU	Provincial Commissioner
Mr. P. COLTON	Prime Ministers Depart.
Mr. R. BRUCE	Regional Forest Office, Department of Forests
Mr. N. SIRIGA	Regional Forest Office, Department of Forests
Mr. M. EVORAMI	Department of Agriculture
Mr. J. SEPJEANTSON	Department of Agriculture
Mr. M. KUSAK	Department of Business Development
Mr. P. CROFT	Department of Business Development
Mr. N. LEET	Department of Natural Resources
Mr. T. MANDE	Department of Natural Resources

APPENDIX II

MISSION'S ITINERARY

Date	Place	Activity
April 1976	19 Mon. Lv. Tokyo	
	20 Tues. Ar. Sydney	Consultation with Japanese Consulate General
	21 Wed. Lv. Sydney	
	Ar. Port Moresby	Conference with Japanese Ambassador
	22 Thur.	Conference with Director of Forest and staffs, including Finance Department Department of Justice and NIDA Data collection from Department of Forests
	23 Fri.	Conference with Minister for Primary Industries and Minister for Transport Data collection from University of PNG Conference with attorney
	24 Sat. Lv. Port Moresby	
	Ar. Madang	Conference with JANT staffs Trip to reforestation area
	25 Sun.	Meeting of mission
	26 Mon.	Conference with Madang Timber Committee

(Group I - Fukuda, Jinguji, Hayashi, Kawamura and Uesugi)

27 Tues.	Lv. Madang	
	Ar. Port Moresby	Conference with attorney
28 Wed.		Conference with PNG government staffs concerned Conference with Japanese Ambassador
29 Thur.		Conference with PNG government staffs concerned

Date		Place	Activity
30	Fri.		Conference with Japanese Ambassador and staffs
		Lv. Port Moresby	
		Ar. Madang	

(Group II - Hachiya, Sakagawa, Okada and Yamada)

27	Tues.	Madang	Field surveys
30	Fri.		

(Fukuda and Kawamura left PNG on April 30)

May 1976	1	Sat.	Madang	Meeting of mission Field survey
	2	Sun.		Field survey
	3	Mon.		Interview with PNG broadcasting office Field survey
	4	Tues.		Conference with Madang Timber Committee and representatives of local land owners Field survey
	5	Wed.		Field survey
	6	Thur.	Lv. Madang Ar. Bulolo	Visit to plywood mill, saw mill and chop-stick factory
	7	Fri.		Visit to Araucaria's reforestation, nursery and logging operation Visit to Ecological Research Institute, Wau
	8	Sat.	Lv. Bulolo Ar. Lae	Visit to College of Forestry, Forest Experiment Station and seed orchard
	9	Sun.	Lv. Lae Ar. Madang	Visit to Botanical Garden and University of Technology

Date	Place	Activity
10 Mon.	Madang	Field survey
11 Tues.		Air survey on reforestation area Conference with Madang Timber Committee Visit to JANT's chip mill
12 Wed.		Field survey
13 Thur.		Meeting of mission
14 Fri.		Conference with Madang Timber Committee
15 Sat.		Conference with JANT staffs Meeting of mission
16 Sun.		Cruising to Island and visit to wood chip carrier
17 Mon.	Lv. Madang Ar. Port Moresby	
18 Tues.		Conference with Japanese Ambassador and staffs Visit to Forest Products Research Center
19 Wed.		Conference with PNG government staff concerned
20 Thur.		Meeting of mission
21 Fri.	Lv. Port Moresby Ar. Manila	
22 Sat.	Lv. Manila Ar. Tokyo	Consultation with Japanese Embassy and JICA in Manila

Note: Messrs. Kuniyasu Wakamori and Akira Nomura, technical staffs of the Japan Forest Technicals Association, had accompanied the mission to survey for making out topographic and reforestation maps.

APPENDIX III
INTERIM REPORT

The Honorable Boyamo Sali, Esq., MP
Minister for Primary Industries
Government of Papua New Guinea

Subject: The Feasibility Study for a Reforestation
Cooperation Project in the Madang Area
(Interim Report on Field Survey by the
Mission of Japan International Cooperation
Agency)

Dear Mr. Sali:

We would like to present to you the summarized interim results of our feasibility survey for the proposed reforestation project in the Madang area of Papua New Guinea. We conducted our investigation from April 21 to May 20, 1976, including field surveys of the government's reforestation, forestry experiments and education and forest industries operations at Madang, Bulolo and Hoskins.

Our mission is the follow-up of the pre-feasibility survey mission which was conducted last July and August at the formal request of the then Minister for Natural Resources, Mr. B. R. Jephcott.

The terms of reference of the mission were:-

- o To report to the PNG government on the results of the previous mission;
- o To exchange views on technical and organizational aspects for the implementation, in co-operation with your Officers, and the promotion of reforestation and afforestation; and
- o To survey and study the technical and organizational feasibilities of the reforestation project in the Madang area.

This interim report, which has been made after several meetings with the government authorities concerned, including the Office of Forests, the Madang Timber Committee and with representatives of landowners in the proposed reforestation area, and following a fairly intensive field survey in the reforestation area, is divided into three parts:-

- 1) The first part is on the reforestation project in the Madang area.
- 2) The second, on the organizational aspects for implementation of the promotion of reforestation and afforestation.
- 3) The last part is on cooperation, on a government-to-government basis.

In this interim report we would like to omit those matters mentioned in the report of our previous survey, and already agreed upon in meetings between the authorities concerned.

1 Reforestation Project: Madang Area

1-1 Implementation and Organization Required for the Project

It would be considered essential for the PNG government to make a detailed and pragmatic plan for early participation by the local people who live or own land in the timber area, so that they may join the newly established reforestation company at the commencement. The shareholders should be finally the people, PNG government and Jant.

1-2 Proposed Basic Principles of the Project

1-2-1 Schedule for Reforestation

- (1) A program of about five thousand hectares reforestation should be carried out by the newly established reforestation company in the next six years, commencing from 1976/77.

Annual program would be 800 ha. in 1976/77, 800 ha. in 1977/78, 800 ha. in 1978/79 and then 2,600 ha. over the following three years.

- (2) Representatives of the landowners in the proposed reforestation area indicated that the people were willing to lease land provided that definite assurance was given that finance was available to develop the leased land. Since the landowners have indicated willingness to lease the land required for the 1976/77 reforestation program, we consider that action should be taken immediately to lease this area by the government, and then negotiations should commence at the earliest possible time for the lease of an additional 1,600 ha. required for the following two years' program, but the lease will not be finalized until finance becomes available to carry out the reforestation program.

(3) This program will require extensive efforts by the PNG government, particularly the guarantee of land leases and security of tenure thereof for the period required. Finance by JICA is required to make the next three years' reforestation program as secure and factual, as suitable areas have been chosen. The next following three years finance will become available as land areas are defined and made available for leasing. The reforestation program should be carried out subsequent to a detailed management plan that took into consideration Jant's logging schedule and the technical problems in the silvicultural field.

(4) The remaining 15,000 ha. reforestation, out of a total target of 20,000 ha. should be seriously considered during the next 3-year period, when it is expected that some of the problems such, as land leasing and technical aspects will be solved.

1-2-1 Technical Aspects for Implementation of the Project

We should be able to get fairly detailed results from the intensive field surveys which we have undertaken this time, and, together with the useful information collected previously, we feel that we can make some useful comments. We consider the following comments are important for the successful implementation of the project.

(1) Basic Criteria Required for Selecting Reforestation Sites

A more rigid standard should be established for selecting sites of the coming three years' reforestation, after consideration of scientific information available.

Land Use Plan called "Scenario 3B" was made upon broadly based criteria of topography, soil and vegetation, and it should not be applied directly into precise site selection for reforestation areas. Local drainage would be one of the most important factors for selection of reforestation sites.

(2) Species for Reforestation

We consider that *Eucalyptus deglupta* would be the first choice as it appears to be the most suitable species for the coming three years' reforestation as its market is expected to be mainly for wood chips. *Eucalyptus*

tereticornis and Terminalia brassii should also be considered for reforestation in suitable site conditions. Terminalia brassii appears to do better in wet sites than other species, including Anthocephalus chinensis, a natural but poor volume/ear. Acacia auriculaeformis may be a good species for reforestation in hill and ramp sites.

We would consider that reforestation experiment of other suitable species for such uses as sawn wood or plywood, as well as woodchips, should be carried out during the reforestation program. The establishment of 20,000 ha. reforestation should have as many species as possible from the ecological point of view.

(3) Seedling Production

We found out by our field survey that there are big differences in growth rates in trees of Eucalyptus deglupta in the plantation areas already established. It would be therefore necessary to implement a seed orchard and seed storage in the early years of the reforestation program in order to select genetically excellent Eucalyptus deglupta.

More testing of the most suitable provenances of Eucalyptus deglupta should be undertaken, particularly to find the most suitable provenances for wet sites and on hills.

Terminalia brassii seed orchard would be necessary to further study the various types and to get enough seeds for a large-scale reforestation program. It is very important that the supply of seedlings should be matched to the reforestation schedule.

(4) Reforestation and Logging Operation

We found out by the field survey that reforestation would cost less than half if it is done immediately after logging, compared with reforestation on sites after several months following logging operations. It has the additional advantage that forest roads and other facilities used for logging could be available for reforestation without additional maintenance cost.

The salvage logging method should be considered, since all standing trees should be used for wood chips and reforestation would be easier. It would not cause any serious problem in soil erosion.

(5) Estimate of Yield

We formed the opinion during the field survey that growth rates of *Eucalyptus deglupta* in the Gogol/Naru would be at least 10 percent slower in general than in Keravat, mainly because there are numerous poor sites caused by poorly drained flat sites or steep hillsides, although some reforestation plots in Gogol/Naru show almost the same growth rate as in Keravat.

Yield of final crop per unit area in the proposed reforestation areas would be less in general than expected since there are some areas in the lease area that are extremely wet and ramp sites where reforestation would be unsuitable.

It would be necessary that further study on estimate of yield in *Eucalyptus deglupta* and *Terminalia brassil* plantations in Gogol/Naru area should be carried out, and then that large-scale reforestation should be carried out by well-organized management plan.

2 Organizational Aspects for Implementation for the Promotion of Reforestation & Afforestation

Since it takes a long period for a harvest to result from reforestation and afforestation, and as it may be adversely affected during the period of growth by such unpredictable factors as damage by insects or diseases, the investment in a reforestation project would be very risk and insecure, and the adequate returns could not be guaranteed.

We understand that there would be many difficult factors to resolve for successful implementation of a private enterprise type of reforestation project. We would consider the following to be especially important factors:-

2-1 Security of Tenure

We consider that the government should guarantee that the reforestation company would have complete control over its land and assets, as specified in its lease, for the period of its lease, and that any ownership changes in the company would be as specified in the original agreement.

2-2 Incentive Schemes for Reforestation

The government should make an early effort to establish suitable tax concessions for reforestation and an insurance guarantee system for a pioneer project.

2-3 Participation by People Living in the Timber Area

Establishment of a strong public relations program would be of considerable importance so that the local people will recognize that the reforestation would contribute not only to their own welfare but also to the socio-economic development of the area. This would also be beneficial in solving the land lease problem, shareholding by the people in the reforestation company, and in protecting the plantations from fire or other damage.

3 Cooperation on a Government-to-Government Basis

3-1 Technical Co-operation and Aid

We would like to report to the Japanese Government that you are very much interested in the following fields for government-to-government technical co-operation and aid, in order to support and assist the reforestation project in the Madang area:-

- 1) Nursery techniques in soil sterilisation; automatic plant container filling; watering and fertilising systems; plant container systems.
- 2) Nutrition studies in the reforestation area with particular emphasis on analysis of existing soil fertility levels in the biomass, and on the subsequent effect of logging and successive forest plantations which may lead to declining levels of soil fertility.
- 3) Alternate logging methods and of different extraction machinery to minimise damage to the soil and other matters of concern. This aspect could be considered in conjunction with various forest management practices, e. g. variations in selecting logging.
- 4) The examination of available machinery that could be used for site preparation prior to planting, e. g. machines that would slash and/or crush secondary growth, and possibly others that could plough mounds to provide planting sites.

5) Field classrooms, accommodation and other facilities at Gogol for use of students from the Forestry College and the University of Technology during practical training exercises.

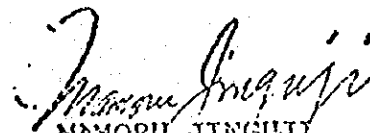
6) Extension to the Forestry College, Bulolo, of wood technology and botany laboratories.

3-2 There was a suggestion at the time of the previous mission's visit that an exchange of views on this project at government level would be useful since large-scale reforestation in a tropical region is in the nature of a pioneer project. We would like to suggest to both governments that a special committee concerned with the implementation of this project should be established at the earliest possible time, and that discussions be held periodically on the various matters involved.

We sincerely hope that the Papua New Guinea Government and Jant will make every effort for successful implementation of this fruitful project.

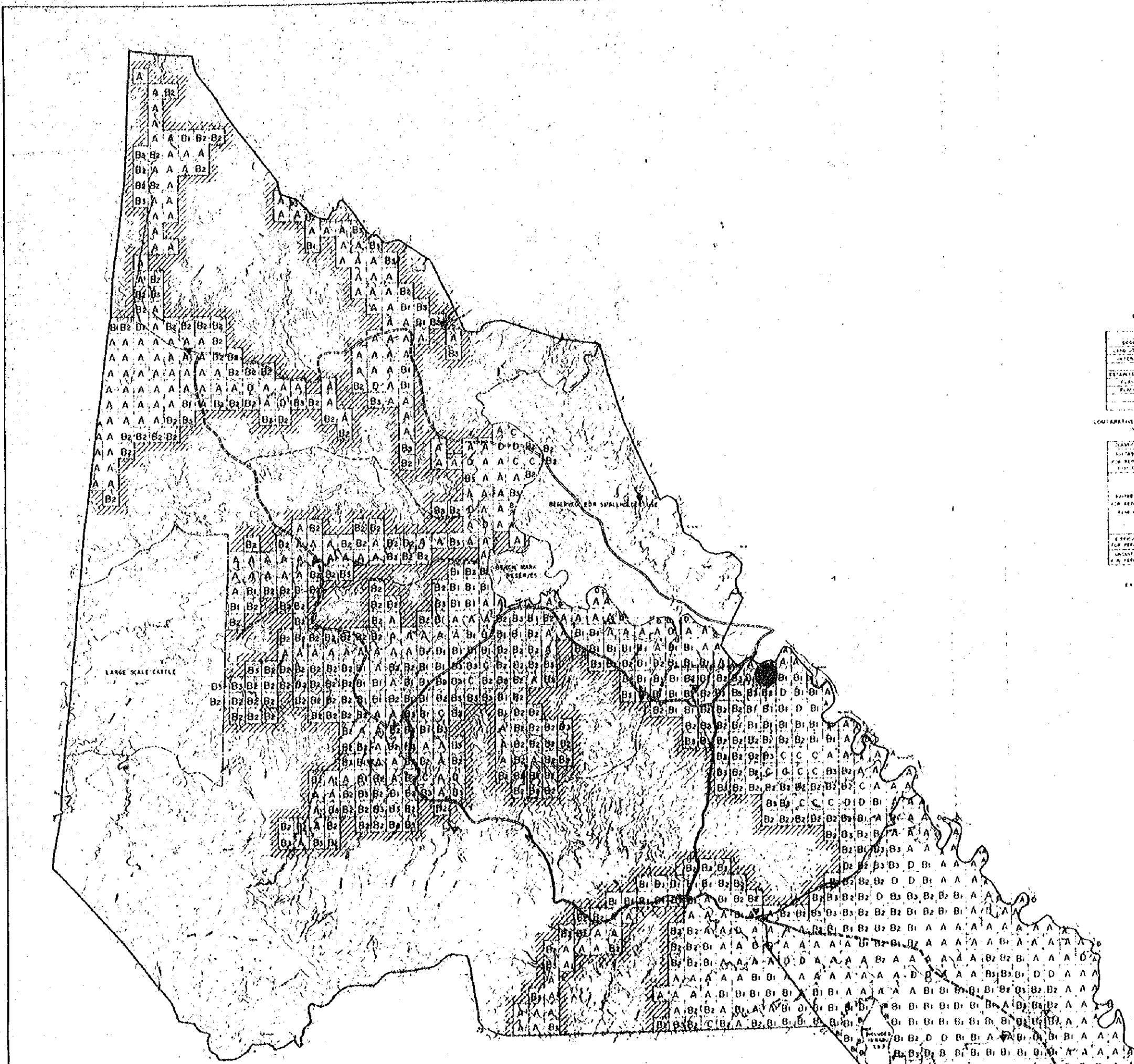
We wish to congratulate you on your happy Independence which was achieved last September, and to express our heartfelt desire to continue good friendships.

Respectfully yours,



MAMORU JINGUJI
Acting Head
JICA Mission for
Reforestation Cooperation

FOREST PLANNING MAP



LEGEND

DISTRIBUTION NOTATION

SYMBOL	EXPLANATION	MAP
□	GOOD WOOD AREA	1
□	POOR WOOD RESTORATION	2
□	INTENSIVE RESTORATION LAND	3
□	EXTENSIVE RESTORATION LAND	4
□	ROAD	5
□	RESERVE FOR SPALLING	6
□	RESERVE FOR CATTLE	7
□	RESERVE FOR FISHING	8
□	RESERVE FOR OTHER PURPOSES	9
□	RAILWAY	10
□	RAILWAY CAMP	11

COMPARATIVE SUITABILITY OF LAND FOR REFORESTATION

INTENSIVE REFORESTATION

CLASSIFICATION	EXPLANATION	MAP
A	EXCELLENT	1
B1	VERY GOOD	2
B2	GOOD	3
B3	POOR	4
C	VERY POOR	5
D	POOR	6

EXTENSIVE REFORESTATION

□

