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# REPORT OF THE SURVEY FOR IMPLEMENTATION PLANNING OF THE TECHNICAL COOPERATION PROJECT FOR THE AFFORESTATION OF THE PANTABANGAN AREA

May 1976

JAPAN INTERNATIONAL COOPERATION AGENCY

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# I. INTRODUCTION

## I-1 Before Present Survey

### 1) Background of Request

Blessed with rich forest resources centering on dipterocarp stands which produce lauan logs, the Republic of the Philippines had long been the main exporter of tropical wood to Japan until several years ago. However, since the regeneration techniques of the tropical forests have not been established yet, it has not always been possible to ensure a proper management of the logged-over area which expanded rapidly in proportion to the increased demand for timber.

In consequence the degradation and deterioration of the logged-over area, which has been a pending problem for the Philippine forestry for decades, has been aggravated to such a stage that the area in urgent need of afforestation is estimated to amount to 5 million hectares in the country.

In particular the deterioration of forests in the important watersheds has become a public concern as one of the causes for the frequent occurrance of floods and draughts in recent years. At the same time it is feared that the overall devastation of the forest land may threaten the sustained productivity of forests in the near future.

Thus the government of the Republic of the Philippines adopted the afforestation and reforestation of open and grass land as one of the most important policies from the viewpoint of improving the productivity of forests and conserving the land. It was in these circumstances that the following requests were made by the Philippine government for the Japanese cooperation in technical and financial aspects in the field of afforestation.

(1) May, 1973:

Request made in a letter from Mr. Tanco, Secretary of the Department of Agriculture and Natural Resources, Philippine Government, to Mr. Urabe, Japanese Ambassador to the Philippines.

(2) September, 1973:

Request made at the meeting with Mr. Sakurauchi, Minister of Agriculture and Forestry, Japanese Government, by Mr. Tanco on his visit to Japan.

(3) October, 1973:

Request made by an official letter of the Philippine Government to the Embassy of Japan.

(4) February and March, 1975:

Requests made by the Department of Natural Resources to expedite the dispatch of a forestry survey mission.

2) The First Survey

After careful examination of aforesaid requests, it was decided to positively respond to them from the following points of view.

(1) The forest resources of the Philippines will surely have a great influence on the timber market of Japan, which has relied and will have to rely heavily on the imported timber for a considerable time to come.

(2) It is of great significance to cooperate in implementing the afforestation projects in the Philippines by advancing various types of cooperation such as intergovernmental technical cooperation and financial and technical cooperation through the Japanese private sector.

Thus the first survey team consisting of the following eight members, organized by the Japan International Cooperation Agency, visited the Republic of the Philippines from April 3 to May 14, 1975.

1. Takehara, Hideo (Head of Mission)

   Ex-Director General, Government Forest Experiment Station

2. Akiyama, Tomohide

   Director of Planning Department, Forestry Agency

3. Kōtari, Katsuhiro

   Special Adviser to the President, J. I. C. A.

4. Hori, Masayuki

   Executive Director, Japan Forest Technical Association

5. Asakawa, Sumihiko

   Chief of Tree Seed Laboratory,
   Government Forest Experiment Station

6. Kuramochi, Takeo

   Head of Development Division,
   Forestry Development Cooperation Department, J. I. C. A.

7. Okamoto, Takakata

   Chief Official for International Technical Cooperation,
   International Cooperation Division, Ministry of
   Agriculture and Forestry

8. Nagatsuka, Yōichi

   Development Division, Forestry Development
   Cooperation Dept., J. I. C. A.

The terms of reference of the team were:

(1) To survey several candidate areas for Japanese cooperation in afforestation, collecting basic data and information necessary for drafting a fundamental plan of the afforestation project.

(2) To exchange views with the Philippine authorities concerned on the technical, organizational, and institutional aspects of the possible Japanese cooperation with the Philippines in promoting the afforestation projects.

In the first half of the survey, the team made a preliminary survey of seven candidate areas for afforestation including four areas suggested by the Philippine government.
As a result of the preliminary survey, the Pantabangan Area was most preferred as a suitable site to initiate a cooperative project of afforestation,

judging from:

(1) the demanding nature of the project that aims at harmonizing timber production and the functions of forests for public good like water and soil conservation in a watershed of national importance;

(2) the geographical location of the object area which is convenient to the effective implementation and management of the project. This area lies in the Central Luzon, about 200 KM north of Manila.
In the latter half of the first survey, the survey activities were concentrated on the field survey of the Pantabangan Area, the characteristics of which will be outlined in the Chapter III.

The followings are the recommendations made by the team as a result of the latter half of the first survey.

(1) The afforestation project in the area will be featured strongly by the requirements for public good such as water conservation

and erosion control in a catchment area of a large dam reservior, as well as outdoor recreation etc. To meet these requirements it should be a prerequisite to solve the technical problems in practising multiple use management of forests in the area concerned.

(2) As to the techniques of afforestation in the area, sufficient information has not accumulated yet, in spite of elaborate activities of existing reforestation projects. Therefore it is proposed to start a technical cooperation project which aims at:

(a) development and improvement of fundamental individual techniques for afforestation

(b) systematization of the individual techniques and examination of economic factors of the afforestation project in the Area

(3) Taking account of the achievements of the technical cooperation project, it might be desirable to proceed to a large scale afforestation project to be implemented by the organization involving the private sector in order to expedite afforestation of the vast open land of about 50,000 ha within the Area.

3) Negotiation on the Principles of Cooperation

At the outset, the development cooperation involving the private sector was contemplated as a mean of implementing the afforestation project. As a result of the first survey, however, it was recommended that intergovernmental technical cooperation should go ahead of the development cooperation which will make use of the organization of the private sector.

To report the results of the first survey and have discussions with the Philippine government concerning the principles of the cooperation on the basis of the reporting, the four members of

the first mission, Mr. Kotari, Mr. Kuramochi, Mr. Okamoto and Mr. Nagatsuka, visited the Republic from October 1st to 10th, 1975.

In the process of the discussion, the Japanese proposal was accepted in principle, and it was agreed to start with a technical cooperation at the first stage. At the same time strong desire was expressed from the Philippine side for the Government of Japan to expedite and expand the afforestation project and to provide a part of local costs including labor cost. The Japanese side explained about the necessity of progressive implementation of the afforestation and about the purport of the technical cooperation. After the evaluation of the report by the Philippine government, an official request was made by a letter to the Japanese Embassy for the dispatch of another survey team from Japan for implementation planning of the Project.

## I-2 Purpose and Members of Survey Team

From the results of the first survey and the consequent consultations with the Government of the Philippines it has been recognized that prior to a large scale plantation, a technical cooperation project should be implemented in order to resolve various problems in afforesting the Pantabangan Area.

Therefore it was decided in response to the request made by the Philippine Government to dispatch a survey team with the following terms of reference:

1) To have discussions with the authorities concerned of the Government of the Republic of the Philippines concerning the master plan and implementing organization of the project as well as the procedures for the initiation of the project;

(2) To conduct a detailed field survey necessary for the implementation planning of the project including the location of proper sites for the administrative office, pilot forests, nurseries and forest roads etc.

The survey team visited the Philippines from December 3rd to 27th, 1975. The members of the team and their itinerary are tabulated in the following pages. The list of the people who cooperated in the survey is also presented so as to express the highest gratitude to them.

## Members of the Survey Team

1. Takehara, Hideo (Head of Mission)

   Ex-Director General, Government Forest Experiment Station

2. Komiyama, Hidenori

   Executive Director, Forest Engineering Consultants Association

3. Asakawa, Sumihiko

   Chief of Tree Seed Laboratory,
   Government Forest Experiment Station

4. Okada, Yoshinori

   Head of Technical Division, Iwate-Fuji Industries Co., Ltd.

5. Nagatsuka, Yōichi

   Development Division, Forestry Development Cooperation
   Dept. J. I. C. A.

## Itinerary of the Survey Team

| | | |
|---|---|---|
| Dec. | 3 | Left Tokyo by air and arrived at Manila |
| Dec. | 4 | Courtesy call to Bureau of Forest Development, Department of Natural Resources |
| Dec. | 5 | Conference at Pantabangan, on the schedule of field survey with Regional Forester, District Forester, and Chief Project Engineer of NIA. |
| Dec. | 6 - 8 | General survey of the Pantabangan Area |
| | 6. | UNDP/NIA/BFD joint project sites |
| | 7. | General observation tour by jeeps |
| | 8. | Aerial survey by a chartered plane |
| Dec. | 9 | Discussions with the foresters and engineers concerned on the results of the general survey. |
| | | Selection of candidate sites for the Project. |
| Dec. | 10 - 11 | Field survey on the candidate sites (Parcel III) |
| Dec. | 12 | Interim evaluation |
| Dec. | 13 - 14 | Field survey on the candidate sites (Parcel II) |
| Dec. | 15 | Field survey on the candidate sites (Parcel I) |
| Dec. | 16 | Interim evaluation |
| Dec. | 17 | Two members of the team (Takehara, Nagatsuka; group A): drive back to Manila |
| | | The other members (group B): processing of data |
| Dec. | 18 | Group A: Discussions with the Head of Afforestation Division, BFD.<br>Reporting the Japanese Ambassador on the survey results |
| | | Group B: Supplementary survey in Pantabangan |
| Dec. | 19 | Group A: Reporting the Secretary of Department of Natural Resources on the survey results |
| | | Group B: Supplementary survey in Pantabangan |
| Dec. | 20 | Group A: Collecting data |
| | | Group B: Drive back to Manila |
| Dec. | 21 - 22 | Preparation of the interim report |
| Dec. | 23 | Submit the interim report at BFD, DNR |

| | |
|---|---|
| Dec. 24 - 26 | Processing data and final evaluation of the survey |
| Dec. 27 | Left Manila for Tokyo |

Philippine Officials Cooperated in the Survey

Mr. Jose Leido, Jr., Secretary, Department of Natural Resources

Mr. Edmundo V. Cortes, Director, Bureau of Forest Development Department of Natural Resources

Mr. Rogelio Baggayan, Chief of Reforestation and Afforestation Division, Bureau of Forest Development, Department of Natural Resources

Mr. Feliciano V. Barrer, Regional Forester, Region 3, Bureau of Forest Development

Mr. Romeo B. Briones, District Forester, Upper Pampanga River Basin Multiple-use Management District, BFD, DNR.

Mr. Oscar, M. Hamada, Jr., Asst. District Forester, UPRBMUMD, BFD, DNR

Mr. Bagadion, Project Director, Upper Pampanga River Project, National Irrigation Administration

Mr. Ramon Palomares, Chief Project Engineer, Upper Pampanga River Project, National Irrigation Administration

Mr. Manuel H. Zambrano, Officer in charge, Pantabangan Field District Office, Bureau of Forest Development, DNR

## II. PRESENT STATUS OF PHILIPPINE FORESTRY

In the Republic of the Philippines, forest area covers about 13 million hectares, 46 % of its 30 million hectares' national land. Of which about 9 million hectares have already been classified as permanent forest according to the land classification now under way. Although there still remain nearly 8 million hectares of unclassified area, it is expected that considerable portion of the area will be converted into agricultural land in line with the Government's policy to increase food production by securing agricultural land wherever possible.

Dipterocarp forests dominate the Philippine forests of about 13 million hectares, over the mossy forest, mangrove, and pine forest, with the acreage of 0.33, 0.26, and 0.21 million hectares respectively.

The forests with high volume and rich in merchantable species, have been logged over rapidly during the past two decades. While the timber exports have contributed significantly to the earning of foreign currencies, the acreage of such rich forests has decreased to reach 4 million hectares. At this rate, it is predicted, even the domestic demands for timber may not be met towards the end of this century.

In the past, such a selective logging system was commonly practised as to harvest trees of specific species with a given diameter or above. Consequently the logging caused a drastic change in the species composition of forests, degrading productivity of the forests. Recently more strict regulations have been put in force in which some promising young trees of valuable species are left uncut. But it is very difficult to excise selective logging properly, and the natural regeneration by this method is not always successful.

On the other hand, the seeds of the species in Genus Shorea, the main indigenous trees of the Philippines, have so short longevity that it seems almost impossible to propagate those species by artificial regeneration which includes the processes of seed collection, sowing,

raising seedlings and planting out. The tree species to be employed in plantations are thus limited to some tropical pines and fast growing species like Albizia and Gmelina. There are some achievements in artificial regeneration by these species in the Philippines. In most cases, however, existing plantations are concentrated on very limited sites, so that no information is available to systematize the afforestation techniques in a large-scale plantation.

Especially the present situation is not rosy at all in the case of afforestation on the open grass lands of nearly one million hectares in the Central Luzon. Because the fertility of soil is severely deteriorated due to the repeated burning for the purpose of pasturing and kaingin. Further more, misfires from the burning practice often spread over the surrounding forest stands to check the growth of young plantations.

At present, the Bureau of Forest Development (BFD) is advancing afforestation program under 89 reforestation projects over the whole country with the target of 900 thousand ha plantation, but the last two decades witnessed only 180 thousand hectares of plantation established and maintained. In consequence, denudation of forest land has been expanding year by year.

The Philippine government, recognizing the serious situation of the forest land, took positive measures to recover the country with rich forests, which were materialized in the form of "the Forestry Reform Code" and "the Revised Forestry Reform Code. "

Under the reform codes, efforts have been intensified more than ever to optimize the benefits that can be derived from forest lands while ensuring the continuity of their productive condition, by advancing the following policies:

1. To promote domestic processing of timber by restricting log export, thus to create more opportunities of employment in the country.

2. To foster the settlement of kaingineros and other upland people by establishing an agro-forestry development program.

3. To encourage industrial tree plantations by granting incentives.

## III. PRESENT SITUATION IN PANTABANGAN AREA

### II-1 Outlook for the Area

The area covers the northeastern part of Nueva Ecija Province, Central Luzon, and adjoins Cagayan River watershed by a branch of Sierra Madre Mountains. Pampanga River taking its source in this divide flows to the south through the central plain and into Manila Bay. Rice culture in the central plain has suffered serious damages very often by the flood of Pampanga River. Consequently it was planned to construct a dam in Pantabangan area and to use it for flood control and irrigation. The dam completed in 1974 by the World Bank loan is located in the east of San Jose along the highway No. 5 and about 180 km north from Manila. The dam reservoir covers nearly 8,000 hectares at full water and the maximum water level is 220 m a. s. l. The catchment area amounts to about 80,000 hectares.

In the area there are two municipalities: Carranglan and Pantabangan. Population in those municipalities is 14,000 and 9,500, respectively. Local people in the area live by scattered pasturing, rice culture (around Carranglan), construction works connected with the dam (around Pantabangan), dry field farming, and logging in natural forests of very limited scale. Especially in Pantabangan municipality where considerable paddy fields were submerged, the shortage of employment may become serious after the completion of construction works related to the dam.

Forests and ranges in the area are under the jurisdiction of the upper Pampanga River Basin Multiple-Use Management District belonging to the Bureau of Forest Development (BFD). Under the District, there are two Reforestation Projects (Carranglan R. P. and San Jose R. P.) under which they are advancing reforestation. There is another reforestation project which was established in a fiscal year of 1975 under the direct control of the Department of Natural Resources.

This project is called "Special Project". In addition, there is also a joint project between the National Irrigation Administration (NIA) and BFD with the assistance of UNDP, which intends to establish plantations mainly along the reservoir side. Both projects have just started planting, and so the staff of the District described above are participating in them either in technical or managerial matters.

## III-2 Natural Environment

### 1) Climate

Annual average temperature is 28°C, and annual rainfall is around 2,500 mm, although it exceeds 3,500 mm sometimes. From November to April rainfall is very little, and the period is rather serious dry-season. The area is located near the border of climatic zones, and rainfall is abundant throughout the year just in the east of the divide (Pacific coast of Luzon Island). Therefore, the peaks of the divide (more than 1,000 m a.s.l.) are always covered with clouds even during dry season.

### 2) Geological Features

The area is classified into two geological types: One is the type with alternate layers of non-solid gravel and shale belonging to new tertiary formation, and the other is the type in which the surface is covered with protruded igneous rock allied to diorite. In the area of the latter type, a number of rocks bigger than head-size are exposed or scattered, but there is few place where rocks are too big to be an obstacle to road construction.

It seems that the characteristics of topography and soils do not appreciably vary with geological features. However, in the area where rocks are abundant as described already, machinery operation will be limited to some extent even if slope is gentle.

3) Topography

The whole catchment area may be classified into the following topographic types: Alluvial, plateau, rolling hills, mountains with little undulations, mountains with abundant undulations, and steep mountains. However, the areas proposed for pilot forests consists roughly of rolling hills and mountains with little and abundant undulations. The relation between topographic types and land productivity should be examined through further experiments. But if convex slope, straight slope, concave slope, foothill gentle slope, and steep slope faced to stream are classified from a viewpoint of micro-topography, it is estimated that the upper part of both convex and straight slopes has lower productivity than others.

4) Soils

Generally speaking, soils in the area belong to red podosolic soil. Surface soil is a little dark and lower layer is reddish brown, although red weathering and podosolization do not seem to be so extreme. This is probably due to wide distribution of immature soil, which results from severe surface erosion. In fact, at the upper part of slope or convex slope the surface layer is shallow and the evidence of surface erosion can be observed. On the contrary, at the lower part of slope or concave slope the surface layer is deep and lower layer is dark reddish brown. Moreover, the soils in this area are generally very hard and dense, and their physical properties are poor.

Soil fertility should be dependent on the difference of topography, geology, and soil. In this area, soils are generally acidic. From the characteristics of soil and mother rock, it is estimated that this area is not so fertile. Especially around the area proposed for the project, soil fertility is closely related to the history as a grassland. The fertility can be estimated by species, size, and color of the grasses growing in the area.

5) Vegetation

Mountaineous area higher than 1,000 m a. s. l. is covered by so-called "mossy forest", which is very low in commercial value, Below 1,000 m a. s. l., they say, the whole area used to be a tropical rain forest, but at present most parts have been logged over except a small portion of natural forest remaining in the southesast.

In the northern part, natural forests of Pinus Kesiya seem to be distributed on the ridges higher than 700 to 800 m a. s. l. Nearly the whole area lower than 800 m is the so-called "Cogon land", which covers about 40,000 ha. They say that some parts have been a grassland for more than 100 years. If Talavera watershed is included, the Cogon land will amount to nearly 50,000 ha. Talavera river is also a branch of Pampanga river, and its watershed is located adjacently in the northwest of Pantabangan watershed and covers about 60,000 ha. In Talavera watershed, forest exploitation took place a little later than that in Pantabangan watershed probably because of steeper slope.

In the Cogon land, some natural forests are often left in a strip or spot, along a stream surrounded by a little steep slope, but all the rest is covered with grasses. Around this area, the vegetational composition of grassland is comparatively simple. Major species are Talahib (Saccharinum spontaneoum), Cogon (Imperata cylindricum), Samon (Samsamong, Themeda triandra), and Runo (Rono, Mischanthus japonicus).

As far as surveyed, the difference in habitat among those four species is not so clear, but it will be possible to estimate soil fertility from vegetative composition and their rowth. In fact, the plant size of either species is very different place to place. Soil fertility may also be estimated by leaf color soon after rainy season.

## III-3 Silviculture

### 1) Nurseries and Seedling Production

According to the annual report (1974 - '75) of UPRBMUM District to which the objective areas belong, about 5, 600 litres of seeds were sown in the nurseries under the District and about 2, 400 litres were seeded directly to the places to be afforested in the fiscal year of 1974. Major species are Albizia falcata, Gmelina arborea, Pinus pinaster, Acacia aureculaeformis, Giant inpil-ipil, and several eucalypts.

Under the District, there are 17 nurseries with the total area of nearly 50 ha. According to the report mentioned above, this size of nursery should be able to produce 25 million seedlings annually. However, the nurseries other than Puncan (San Jose R. P. ), Talatalan (Carranglan R. P. ), and Marikit (UNDP-NIA-BFD) are subsidiary and have not been developed sufficiently. At present, the actual area for seedling production is only about 10 ha, including three central nurseries mentioned above.

According to the annual report, about 4. 35 million seedlings were produced and about half of them were planted out in the district in 1974. However, proper seedlings are not necessarily produced because of delayed distribution of seeds and shortage of budget. During the period of survey, the following nurseries were visited: Capintalan, Puncan, Talatalan, Marikit, and conversion. Marikit nursery seems to be the most modernized nursery in this area. It is still under construction, but there are two shade houses and a watering system with well although manual. The only neck for the expected production of seedlings seemed to be shortage of seeds. Conversion nursery is the nursery for the Special Project under the direct control of DNR. During the period of the first survey (1975, 4 - 5), a temporary nursery in the east

of Conversion was visited, which was managed to supply seedlings for the Special Project. In December, 1975, however, a new facility including nursery had been established in the west of Conversion. The nursery is still under construction, but steps are being taken for further activities.

2) Reforestation Activity in 1974.

According to the annual report mentioned above, the total area reforested in 1974 is 1,212 ha. Major species used for reforestation are Acacia (113 ha), ipil-ipil (106 ha), Pinus kesiya (91 ha), Cashew (85 ha), Narra (61 ha), long-leaf mahogany (45 ha), and Gmelina (21 ha).

3) Outlook of the Existing Plantations

Reportedly, the total area of plantation in the District amounts to 10,289 ha including 1,212 ha planted in 1974. Most of the plantations seem to be located along public roads or forest roads, or near nurseries, but probably no plantation is not damaged by fire. Therefore, even the present condition of the stands suffering comparatively less damage may not be used for estimating a normal performance at the age. In addition, most of the plantations showing comparatively good performance are very limited in size. In an extreme experession, no plantation can be helpful in predicting normal growth in this area.

(1) Carranglan Reforestation Project

Plantation adjacent to the project office at Talatalan: From the office to Talatalan nursery, there are teak plantation (6 to 8 years old) and small trial plantation of Gmelina (2 yrs old). The latter and a part of the former are for testing the effect of fertilization. The effect is clearly observed although the variation within each treatment is very large. The variation may be caused not

only by an individual and micro-site condition, but also by fire damage.

Plantation located in the north of the office: This is one of the best plantations visited during the survey period. The plantation includes Swietenia macrophylla, Tectona grandis, and Pinus kesiya. All the species show a good performance, albeit a very limited area.

New plantation in the east of conversion: They say this plantation was es blished during the rainy season in 1975. The species are Gmelina, giant ipil-ipil, Albizia, etc., but it is too young to evaluate the performance.

(2) San Jose Reforestation Project

Plantation near Capinatalan: This is Pinus kesiya plantation established in 1960. They say the total area of the plantation is about 600 ha.

Plantation near Minuli: The plantation of P. kesiya was established in 1971. The performance is rather good, but the survial percentage is a little low.

Plantations adjacent to Puncan nursery: Three plantations of teak, P. kesiya, and Narra (Pterocarpus indicus) were visited. The performance of teak and Narra is very good, although there is a variation. Data for predicting the growth of teak and Narra may be obtained in those plantations.

Teak plantation at Tayabo (Camp IV): This is also one of the best plantations in the area. They say that a part was planted in 1939 and some part was directly seeded in 1953. The performance of both parts, especially the former, is very good.

(3) Other Plantations

New plantation under the Special Project: In the west of conversion, there is a new plantation under the Special Project of the DNR. The total area established in 1975 is about 600 ha. Cashew seedlings were planted for about half of the total area and other major species are Giant ipil-ipil, Gmelina, Albizia, Mahogany, and Agoho.

New plantation in Bocanegra: The area is planted during the rainy season of 1975 as a joint project of UNDP, NIA, and BFD. Major species planted are Eucalyptus camaldulensis, Pinus caribaea, P. oocarpa, etc. The rate of survival is not so bad, but subsequent growth is rather poor and many of the seedlings planted show the symptom of nitrogen-deficiency.

4) General Comments

Based on the performance of the existing plantations, the following matters may be pointed out. The most important problem to be considered is fire damage. If the plantations are not protected from fatal damage of fire, the investment to afforestation will be meaningless. Actually any of existing plantations has been suffered exposed to fire more or less, and there are few plantations where the information for growth prediction can be collected. It is, of course, important to educate local people and also to improve fire-prevention system, but from the technical point of view it will be effective to establish fire-break or to construct an appropriate network of working forest roads serving also as fire-break.

The points in silvicultural techniques are summarized as follows: Considering the aim to cover devastated grassland with forests as soon as possible, fast growing species should be tried for the earlier stage, but pines and broad-leaved species for longer rotation should also be examined as widely as possible because site conditions does not seem to be suitable for fast growing species and

also because the performance of existing plantations does not necessarily suggest the hopefulness of fast growing species.

In pines, Pinus kesiya plantations do not necessarily show promising results, and so conceibable causes may be studied. At the same time, it is desirable to introduce tropical pines other than P. kesiya and to carry out provenance or pedigree test with the species whose materials can be obtained. Among the broad-leaved species for longer rotation, teak, mahogany, and Narra will probably be major species, because there are good plantations in the district, although all of them are in a small scale. Nevertheless, as many species as possible should be tested for their permance if their seeds can be collected.

A symptom of nitrogen deficiency is rather generally observed in the plantations established recently, which indicates that soil productivity has been decreased seriously and that appropriate fertilization should be effective especially in improving early growth. As soil is very hard, ploughing will also be promotive for early growth. To improve the effect of fertilization, it may be worthwhile to combine ploughing with fertilization.

It seems that the size of seedlings may be one of the reasons for poor performance and especially for poor early growth. To produce an appropriate size of seedling, there seem to be some problems to be solved in the nursery practices.

### III-4 Forest Roads and Soil Conservation

The objective area is 180 to 190 km far from Manila. The national highway No. 5 has almost been paved from Manila up to San Jose. From the national highway, a provincial road is branched at Digdig leading Carranglan. The provincial road is spread with gravels

and bridges are not maintained well. Some bridges have been lost probably by floods. Therefore, it is almost impossible to transport heavy machines to the objective areas via the provincial road of existing condition. Road width needs to be extended and bridges needs to be improved.

The road system within the area varies from place to place. In the south of the reservoir, public roads have been improved for dam construction. Using those roads, there is no great difficulty to approach the area for forestry use. In the east to northeast side of the reservoir, however, there is almost no road in use over the area, and so it is very difficult to approach the area proposed. As described already, there is a comparatively good system of provincial road around Carranglan, by which barrios are connected each other. But even there those roads are not connected with the area proposed.

The surface soil of the proposed area belongs to the soil series called Annam clay loam or Annam sand clay loam, which is rich in clay. The lower base belongs to Neocene or diluvial formation, consisting of alternate layers of non-consolidated gravels, sand and clay. In the base of the area, there also seems to be a considerably broad distribution of igneous rocks, because stones of granite and andesite or diorite are observed on the bed of Diamman and Manablon river.

From the conditions mentioned above, no particular difficulty will be anticipated in constructing the roads proposed. In addition, materials for construction may be obtained near-by.

In the places with poor vegetation, ditches or cracks are formed by rainfall, because the soil is rich in clay as described above, and annual rainfall exceeds 2,000 to 2,500 mm, with a concentration in a rainy season less than half a year. Therefore, in case that various works such as cutting or banking are performed or surface vegetation is stripped off, appropriate hillside works or drainages should be required. Such a consideration should be necessary not only from the

III-5 Machinery

Most parts of the area proposed are grassland with a gentle slope of 0 to 15°. In the planting work on slopes, generally speaking, the use of machines is greatly limited according to land conditions such as topography and geological features. In the area proposed, however, various machines for forestry use may be introduced without serious trouble, except steep slopes appearing partly, small basins, and areas along streams.

Around the area, at present, all the afforestation works seem to be carried out with various manual tools, including seedling transportation, ground preparation, digging planting holes, and planting. Apparently the present system of planting is not suitable for establishing large scale plantation.

Considering the soil conditions described already and the performance of existing plantations in this area, some sort of ploughing will be effective in improving the survival and subsequent growth of planted seedlings. It is not easy to carry out this sort of manual works on slopes, and so an exclusive machine power should be introduced for each work su such as removing gravels, shallow ploughing, or digging planting holes.

In this area, they have few logging machines and relating heavy machines, because a distribution of natural forest is very limited and logging is prohibited. But the workers in this area seem to be familiar with those heavy machines because there are large motor pools under NIA and road construction works are still under way. Around the area, however, there is no private motor pool where heavy machines can be repaired.

The problem faced in mechanization is how to operate and maintain the machines as mentioned above. As known well, jipness and and tricycles are very popular in the Philippines. Even in the countryside, there are some repair-shops mainly for repairing those jipnees and

tricycles everywhere. This sort of repair-shops are not always equipped well, but they usually have necessary facilities such as welding machine, compressor, lathe, etc. It is very sure that their techniques to repair machines are at an appreciable level.

On the other hand, agricultural machines are skillfully used around the area, which indicates that operation techniques of the machines may easily be mastered. As the success in afforestation works using tractors depends especially on the operation techniques of drivers, in the beginning it will be very important to improve their operation techniques.

# IV. OUTLINE OF THE COOPERATION PROJECT

## IV-1 Basic Plan

This technical cooperation project aims at the development, education, and training of various techniques necessary for afforestation, so as to contribute to the large-scale afforestation to cover a devastated grassland amounting to nearly 50,000 ha in Pantabangan area. To achieve the object, first the development of individual techniques for afforestation is preceded. Subsequent step is to establish the test plantations of minimum size in which planting and logging can be repeated on an industrial scale. In the test plantations, studies will be carried out for the systematization of various afforestation techniques, including the forest management on an industrial scale, the establishment of forest protection system in liaison with local people, etc. At the same time, necessary training may be done both in Pantabangan and in Japan for the extension of those techniques developed.

Both for Japan and the Philippines, this project is the first technical cooperation in forestry. Therefore, in the opinion of the team necessary modifications should be made during the earlier trial period for cooperation before a formal agreement is concluded. Consequently it is recommended that for the ealier two years the cooperation be based on the record of discussions, and then followed by the cooperation for about five years under an agreement. Thus the cooperation plan is prepared for seven years in total.

For the implementation of this project, a central office and a technical cooperation center will be established in DNR and in Pantabangan area, respectively. Practical activities for afforestation will be carried out by utilizing the organization and staff of existing reforestation projects in the District, under the guide and supervision of the Japanese experts and the Philippine counterparts at the center office. In the project, practically, the following items will be pursued while establishing the pilot forests amounting to nearly 8,100 ha in three parcels.

1) Development of Requisite Techniques

(1) Development of Individual Techniques
(Trial plantation: 1,300 ha)

① Examination of appropriate species

The following 14 species are tested for each of three site classes.

(a) Fast-growing species: Albizia falcata, Leucaena pulverulenta, Gmelina arborea, Casuarina equisetifolia, Eucalyptus deglupta

(b) Pines: Pinus kesiya, P. merkusii, P. caribaea, P. elliottii, P. oocarpa

(c) Broad-leaved species with longer rotation: Tectona grandis, swietenia macrophylla, Cedrela odolata, Pterocarpus indicus, Eucalyptus deglupta

② Examination of planting method

Ordinary planting, ploughing (larger planting hole, strip ploughing), fertilizing, direct seeding, bare-root seedling, nest planting, seedling size, planting density, planting preceded with soil improvement species, mixing with soil improvement species, etc.

③ Examination of nursery practices

④ Examination of countermeasures against fire damage or damage due to insects and diseases

⑤ Examination of techniques for forest road construction: Cutting, banking, protection of road surface, draining method, etc.

(2) Examination of Operation and Management

(Test plantation: 6,800 ha)

① Systematization of afforestation techniques:

Establishment and standardization of operational system with various combinations of individual techniques, Mechanization of part of operational system, Control of plantation density, etc.

② Examination of balance between incomings and outgoings on an industrial scale: Thinning method, logging techniques, working forest road network and economic balance, etc.

③ Relation to natural environments: Experiments and surveys on the effect of afforestation on natural environments, such as soil and water conservations, etc.

④ Relation with local communities: Trials on organizations of forestry workers, systems for forest protection, agro-forestry, etc.

⑤ Other items: In addition to the experiments mentioned above, surveys may be done on the conservation and regeneration of natural forests around the objective area of this project.

2) Education and Training

Training is given to the personnels for the extension of techniques necessary for the establishment of trial and experimental plantations.

Training for nursery practices and afforestation

Training for the operation and maintenance of machines

Training for the establishment and maintenance of forest roads

Those trainings listed here are given in the area proposed, and in connection with those trainings, training may also be given in Japan to the trainees invited.

## IV-2 Implementing Organization

### 1) Existing Organizations in the Area

For the reforestation in Pantabangan area, the following projects are existing at present.

① Reforestation projects under BFD:

There are two projects: San Jose and Carranglan Reforestation Projects. As mentioned in the chapter III, each project has a field office and several nurseries.

② Special reforestation project under DNR:

To promote the reforestation activities in this area, the DNR created a new special project directly supervised by DNR in 1975. A new field office attached with nursery was built near conversion in the north shore of Pantabangan reservoir.

③ Greening project under NIA

In cooperation with UNDP and BFD, NIA is proceeding a kind of afforestation project in relation to Pantabangan dam project. In 1975, a new nursery was established at Marikit and a trial plantation of some eucalypts, some pines, etc. was established at Bocanegra.

④ Research project by Pantabangan branch of FORI

There is a branch of FORI just adjacent to the district office, which expects to start a new research project on afforestation and watershed management. The FORI has an experimental forest near Carranglan.

4 Research project by Pantabangan branch of FORI

There is a branch of FORI just adjacent to the district office, which expects to start a new research project on afforestation and watershed management. The FORI has an experimental forest near Carranglan.

Pantabangan area is under the jurisdiction of the Upper Pampanga River Basin Multiple Use Management District (UPRB-MUMD), which was established in 1971 and since then has been a center for research, education, and training as a model district office for the "study of multiple use management in forest land" under the cooperative project between UNDP and BFD. Two Reforestation Projects described in (1) belong to this District, and the assistant district officer is managing the special project described in (2). The District is also cooperating technically with the project described in (3).

2) Implementing Organization Proposed

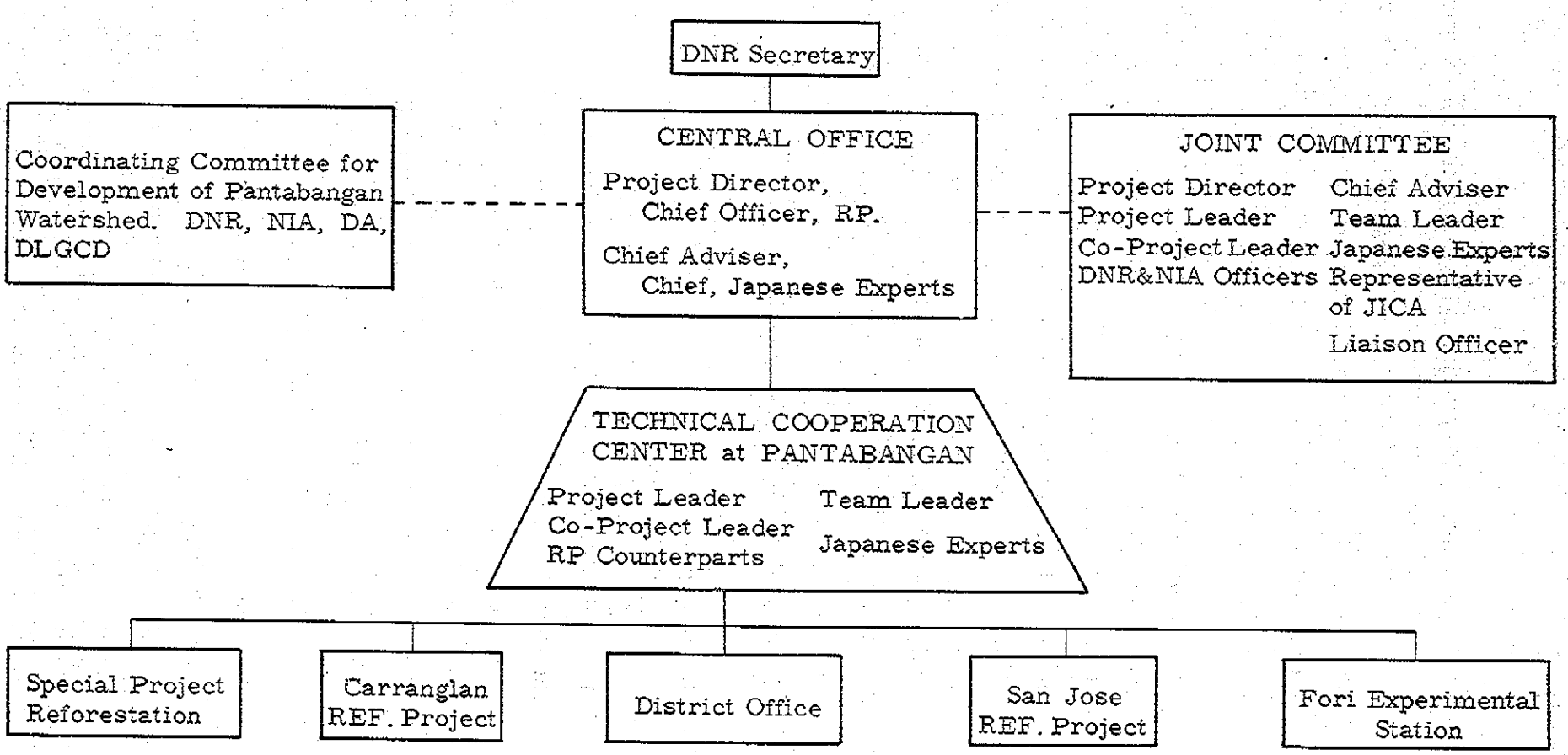
The implementing organization of this cooperation project is to be established in and by the Philippine Government. Therefore, an idea the mission believes the most desirable will be presented just for the consideration in the Philippine Government. The following organization and implementing system will be desirable to accomplish this project efficiently, considering the existing organizations described in the previous section. (See Chart I.)

The central office and the Philippine-Japanese joint committee are established at the central office of DNR. The central office runs the joint committee and let the technical cooperation center in in Pantabangan carry out the activities of the project based on the guidelines of the annual work plan to be formulated by the joint committee. The joint committee consists of the representatives from both countries and deliberates on the important matters

## CHART I. ORGANIZATION CHART

PANTABANGAN AFFORESTATION PROJECT

(Technical Cooperation in Afforestation at Pantabangan Watershed)



relating to the implementation of the project, such as the determination of yearly plan, etc.

The project director from the Philippine Government supervises the central office. He is also a chairman of the joint committee and has a responsibility for an administrative matters of the project. To support the project director in technical and procedural aspects, a chief advisor from the Japanese Government will be attached to the central office. The chief advisor also represents the Japanese experts who undertake a technical guidance in the field.

The Philippine-Japanese technical cooperation center for the afforestation in Pantabangan area is established in Pantabangan area. This center is the implementing body of this project. The detail of the center will be described in the following section, but in short the Japanese experts and the Philippine counterparts are stationed at the center, and undertake guidance and supervision necessary for the technical development, education, and training to meet the aims of this project. The head of the center is appointed from the Philippine counterparts and a team leader is appointed from among the Japanese experts working for the center.

To contribute to the development of the local communities through this cooperation project, a coordinating committee for the development of Pantabangan watershed is organized. This coordinating committee recommends to the joint committee and central office described above, from a viewpoint of effective local development.

## IV-3 Technical Cooperation Center

The technical cooperation center consists of an administrative office and related facilities, pilot forests, and nurseries. During the survey, suitable sites were selected for those facilities, and the size

and function of each facility studied. (The results are as follows: )

1) Center Office (Administrative office and related facilities)

It is advisable that the office be established in the UPRBMUMD office at Maringalo, Carranglan, Nueva Ecija Province. The reasons for this are as follows: The district office is located along the provincial road branching from the national highway No. 5 and reaching the objective areas, which is very favorable to manage this project. The district office is improving the existing office building and constructing a new guest house. It appears that a part of their office and some of annex buildings may be used for this project, which may save the expenditure of the Philippine side.

All the Japanese experts and the Philippine counterparts except the project director and the chief advisor are stationed at this office. Their major work is to guide and supervise the practical activities for the technical development, education, and training as described in the basic plan (Section 1 of this Chapter) and the program of the project (Chapter V), in accordance with the directions of the central office.

In addition, the administrative office and related facilities take care of the equipments and materials used for the project activities and also undertakes the fundamental researchs necessary for the project. Consequently, the office needs to be equipped with various office supplies including typewriter and copy machines, meteorological recorders, seed stocker, and some other equipments and materials. The related facilities include garages, sheds for operational machinery, and workshops for the machinery, as well as, the accommodation facilities for the experts, counterparts and trainees, which are very important prerequisite in advancing this project.

2) Pilot Forest and Nurseries

As described already, this project aims at establishment of afforestation systems favorable to both watershed management and timber production. To accomplish the aim of the project, pilot forests should be established and their performance should be examined also from a viewpoint of watershed management. The areas suited to pilot forests and nurseries were selected during the survey. Those areas will function as the fields for the technical development, education, and training in the cooperation center.

(1) Pilot forest

Pilot forest are located in three parcels, considering the difference of environmental conditions such as topography, soil, direction of major slopes, wind direction, history as a grassland, etc. The areas for trial plantations were selected on comparatively gentle and less rolling slopes in the whole area proposed. An approximate size of the areas selected is as follows, and an approximate location is indicated in Fig. I.

Southwest of Pantabangan reservoir (Parcel I)

Pilot forest: 1,100 ha which include two trial plantations of 300 ha each. One of the trial plantations is isolated from Parcel I.

Northwest of the reservoir (Parcel II)

Pilot forest: 3,800 ha (in two blocks), which include two trial plantations of 200 ha each.

Northeast of the reservoir (Parcel III)

Pilot forest: 3,000 ha which include 100 ha for trial plantation.

Model trial plantation: 200 ha which are not included in any of three parcels.

The grand total is 8,100 ha, of which the area for trial plan tation is 1,300 ha in total.

( Model trial plantation )

A certain size of plantation adjacent to the administrative office will be necessary to facilitat various detailed experiments for which a constant observation or survey is required. At present, however, there is no space around the district office. Nearly all the area around the office seems to be leased for pasturing. Efficiently to advance this technical cooperation project, the area of some 200 ha for trial plantation is desired at the location within ten to fifteen minutes' drive from the center. During the survey, the area for this purpose could not be selected, but it is expected that the District will look for some appropriate area by the start of this project.

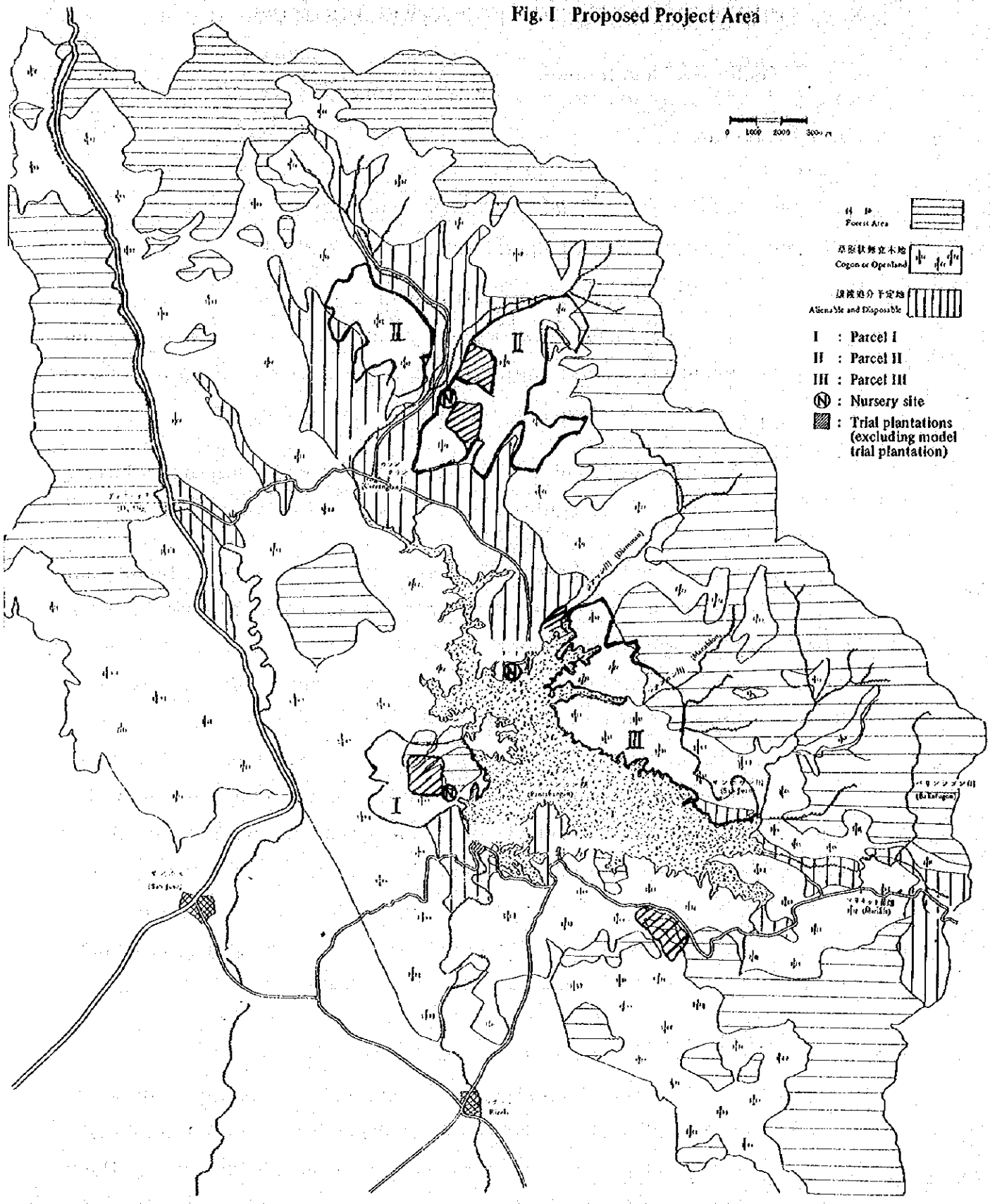
(2) Nurseries

Establishing the pilot forests mentioned above requires a large expansion and a considerable improvement of nurseries. For the earlier stage, however, the size of nurseries necessary for the establishment of trial plantations and the experiments in nursery practices will be considered. During the last survey, a priority was given to the improvement of existing nurseries near the areas proposed for trial plantation. Eventually the following areas were selected for new nurseries.

2 ha in Parcel I 3 ha in Parcel II 4 ha in Parcel III

The location and rough sketch of each area are illustrated in Fig. I and II

## Fig. I Proposed Project Area



# V. PROGRAM OF THE COOPERATION PROJECT

## V-1 Technical Development

### 1) Silviculture

#### (1) Species to be examined

① Fast growing species

There are various difficulties such as unfertile soil condition, severe dry-season, etc., but for the first step it may be necessary to take the following fast growing species on which some information has already been accumulated.

Albizia falcata, Leucaena pulverulenta, Gmelina arborea, Casuarina equisetifolia, Eucalyptus deglupta

However, their performance in the newly established plantations and severe site conditions may not necessarily promise a successful afforestation with fast growing species. There may also be some fear in a future demand in view of long-term aspect even if a tentative success will be obtained. Moreover, a large scale plantation of a single species may not be safe from the ecological point of view. Considering the conditions expected, the diversity of species is particularly desirable not only to meet a future demand in many ways but also to protect plantations from various damages by ecological stability. Therefore, the species other than fast growing species should also be examined as widely as possible.

② Pines

It is well known that pines can grow even under unfertile soil condition. Pines also have a great demand for pulp material of long fibre. The species to be considered first is Pinus kesiya native to the Philippines. The natural distribution of

P. Kesiya is over several provinces adjacent to the northwest of the area. The species are also distributed naturally above 700 m a. s. l. in the northeastern part of the area. For afforstation of this species, therefore, superior trees from various points of view should be selected in its natural stands over the whole distribution. However, the problem faced is that the performance of existing plantations in the area is generally poor. The reasons for this should be studied and also an introduction of other pines should be examined.

Another native pine, P. merkusii, will be one of the prospective species. Natural stands of P. merkusii in the northern Zambales should be a valuable seed source, but the strains in Mindro Island will be worth introducing. If possible, it is desirable to introduce the materials from Indonesia and Indo-Chinese countries and to compose them with native materials. The possibility should be examined also with P. caribaea, P. elliottii and P. oocarpa, but it is important to describe their seed origins because there is rather widely observed the so-called "fox-tail" phenomenon which may be due to genetic character.

③ Broad-leaved species for longer rotation

Another group to be considered for the diversification of planting materials may be broad-leaved species with longer rotation period, in other words for timber production. Species with which experiences have already been accumulated in this area are teak (Tectona grandis), long-leaf mahogany (Swietenia macrophylla), and Narra (Pterocarpus indicus). Good plantations of those species are scattered around although in a limited scale. In addition to those species, the following species may be examined: Eucalyptus deglupta, Cedrela odorata, Darberdia latifolia, Cassia siamea, etc.

④ Other species

Under the Special Project of DNR, Cashew is planted to a large extent. Cashew fruits ensure a stable livelihood to the local people by constant employment and good income. As fruit trees have such merits, they may be prospective species for the plantations around the settlements.

(2) Experimental items

① The size of seedlings - Period for growing seedlings

One of the problems which have been recognized through the surveys is that seedlings for planting are not appropriate in size. This seems to be mainly due to the short period for growing seedlings. Seedlings are much shorter than the standard size described in the handbook for nursery practices. This fact may partly explain the poor performance of plantations established recently. Fertilization may be one of the ways to promote the growth of seedlings, but the first item to be examined is to prepare seedling with different sizes by changing the period from sowing to planting out. The effect of seedling size is examined on survival and subsequent growth.

② Type of seedling for planting out

In the area where they have severe dry season, most seedlings are potted except some species. Using potted seedlings, however, transportation from nursery to field and movement in the field are certainly the necks in planting practices, in connection with undeveloped mechanization. In fact, in Baguio they say that the ratio of bare-root seedlings in Pinus kesiya is increasing and amounts to nearly 30% in the fiscal year of 1974 to 1975. Considering the ways to overcome their demerits such as limited planting time and drying up during transportation, the possibility will be examined on the afforestation using bare-root

seedlings. In addition, the time and method for direct seedling will be examined because there is an excellent plantation of teak by direct seeding.

③ Planting method – Size of planting hole and ploughing

According to the guide-line, planting hole is defined as 30 cm both in diameter and depth. Practically, however, it seems that seedlings are planted into much smaller holes. The area is generally covered with compact soil, and so planting holes should be prepared as largely as possible and also be ploughed. In addition to the experiments for the size of planting hole also showing the effect of ploughing, the following planting methods may be examined: Planting after ploughing all over the surface in the area with an easy grade and terrace planting in the area with a considerably steep grade.

④ Fertilization

To observe in detail, soil productivity varies with local topography. Generally speaking, however, the productivity is greatly lowered by having been a grassland for many years and also by repeated grazing. The early growth of a few new plantations observed in this survey was very poor beyond our expectations, and the symptom of nitrogen deficiency was observed over a wide area. In the area there are some trials of small-scale on fertilization, which show the distinguished effect of fertilization. However, systematic experiments of larger-scale are greatly needed.

In practice, composite fertilizers may be applied by N: 20 grams per seedling for fast-growing species and broad-leaved species with longer rotation and by N: 8 grams per seedling for pines. But composite fertilizers containing more phosphor should be applied for the species whose roots have nodular fungi,

for example, legumes and Casuarina equisetifolia. The following is an idea for the kind of fertilizers and the quantity to be applied:

Fast-growing species and broad-leaved species, excluding the species of the third group (20-10-10 : 100 g/seedling : 250 kg/ha)

Pines (20-10-10 : 40 g/seedling : 100 kg/ha)

Species whose roots have nodular fungi (13-17-12 : 150 g/seedling : 375 kg/ha)

Effect of nitrogen or phosphor alone had better be examined partially. In any case, careful attention is needed for how to apply, especially the time to apply, because fertilizer damage may be caused without appropriate rainfall after or before fertilizing. At least, fertilizers should not be applied at the time of planting. Repeated application with some increase in quantity year by year or every other year may be one of the items to be examined. If time is allowed, soil-improving species may be planted first and then after some years the species concerned may be planted. If not, however, the species concerned may be mixed in alternate rows with soil-improving species.

⑤ Number of seedlings planted

The number is ordinarily 2,500 seedlings per ha, i.e. 2 x 2 m, except ipil-ipil (Leucaena leucocephala), Kakawate (Gliricida sepium), etc. which are directly seeded for erosion control. However, the species proposed include those which have not been planted in this area. In addition, a tending system has not been established yet for most of the species which have been planted in this area. Therefore, the experimental plots in which tending systems may be examined in the future should be taken.

⑥ Wind-break belt

In this area, especially in the central and southern parts, they have a rather strong east-wind. Wind-break belts may be effective in protecting young plantations from the wind in some parts. Therefore, some experiments may be done in connection with species selection, growth promotion, and tending for wind-break belt.

⑦ Systematization of individual techniques

The individual techniques mentioned above must be combined in various ways to meet different managerial purposes. Therefore, the experiments should be enlarged from small-scale to operational scale, so that the balance between incomings and outgoings can be examined. Moreover, a logging system including thinning should be established, which must be consistent with the management of critical watershed.

⑧ Yield pradiction and management plan

Forest management aims not only at the increase of yield but also at annually successional production. To meet those targets, it is necessary to investigate a yield per unit area and to determine an annual cutting amount, reforesting area, etc., based on the yield per unit area. Around the area proposed, however, there are very few plantations in which growth data can be collected for each species. There are also few stands to be logged. Therefore, it is certainly necessary to survey the performance of the pilot forests including both trial and experimental plantations annually, to prepare the yield table for each species, and to devise appropriate management plans based on the yield table.

(3) Yearly plan of planting area and experimental design

The objective areas in Parcels I, II, and III are 1,100 ha, 4,000 ha, and 3,000 ha, respectively, including both Phases 1 and 2. The experiments described above are carried out within an area for the Phase 1 of each parcel.

Table 1 shows the yearly program of planting in each parcel for fast-growing species, pines, and broad-leaved species with longer rotation. It will be reasonable that planting in the Parcel III is started one year later, considering the present situation of nurseries and access roads. In the Parcels I and II, planting in the first year should also be limited to fast-growing species and pines, in view of the period for growing seedlings.

On such an assumption, the area for various experiments in the Phase 1 is estimated as shown in Table 2. Treatments in each experimental item are as follows: Seedling size - 2; type of seedling (potted or base-root) - 2; planting method - 2; fertilization - 3; number of seedlings planted - 1. Ten series of those treatments combined partially are made standard, and several series combined with terrace planting, different planting densities, etc. are added. Table 3 shows the seed quantity necessary for producing seedlings to be planted for the area as indicated in Table 2.

(4) Enlargement, improvement, and new establishment of nurseries

As shown in the yearly program of planting, a maximum planting area through the phases 1 and 2 is 3,000 ha in the last year, when at least 7.5 million seedlings are needed. According to the annual report of UPRNMUMD, 250 thousand seedlings can be raised in one hectare of nursery in this area. Therefore, nearly 30 ha of nursery should be established newly, if seedling production for this project has to be carried out in no connection with existing

Table 1. Yearly Plan of Planting Area

| | 1977 | 1978 | 1979 | 1980 | 1981 | Total |
|---|---|---|---|---|---|---|
| (Phase 1) | 200HA | 400HA | 700HA | | | 1,300HA |
| (Phase 2) | | | 1,300 | 2,500 | 3,000 | 6,800 |
| Total | 200 | 400 | 2,000 | 2,500 | 3,000 | 8,100 |

| | Phase 1 | Phase 1 | Phase 1 | Phase 2 | Phase 2 | Phase 2 | Phase 1 | Phase 2 | Total |
|---|---|---|---|---|---|---|---|---|---|
| (Parcel I) | 100 | 150 | 350 | 500 | | | 600 | 500 | 1,100 |
| Fast Growing Sp. | 50 | 60 | 140 | 200 | | | 250 | 200 | 450 |
| Pines | 50 | 60 | 140 | 200 | | | 250 | 200 | 450 |
| LR Species | | 30 | 70 | 100 | | | 100 | 100 | 200 |
| (Parcel II) | 100 | 150 | 350 | 500 | 1,900 | 1,000 | 600 | 3,400 | 4,000 |
| Fast Growing Sp. | 50 | 60 | 100 | 100 | 500 | 300 | 210 | 900 | 1,110 |
| Pines | 50 | 60 | 150 | 200 | 700 | 400 | 260 | 1,300 | 1,560 |
| LR Species | | 30 | 100 | 200 | 700 | 300 | 130 | 1,200 | 1,330 |
| (Parcel III) | | 100 | | 300 | 600 | 2,000 | 100 | 2,900 | 3,000 |
| Fast Growing Sp. | | 40 | | 100 | 200 | 600 | 40 | 900 | 940 |
| Pines | | 40 | | 100 | 200 | 700 | 40 | 1,000 | 1,040 |
| LR Species | | 20 | | 100 | 200 | 700 | 20 | 1,000 | 1,020 |
| Total Fast Growing | 100 | 160 | 240 | 400 | 700 | 900 | 500 | 2,000 | 2,500 |
| Total Pines | 100 | 160 | 290 | 500 | 900 | 1,100 | 550 | 2,500 | 3,050 |
| Total LR Species | | 80 | 170 | 400 | 900 | 1,000 | 250 | 2,300 | 2,550 |

Note: LR Species is broad-leaved species with longer rotation

Table 2. Area of Trial Plantation by Parcel, Year, and Species

| | Area (HA) Total | by Year | | Treatments | Species |
|---|---|---|---|---|---|
| Parcel I | | | | | |
| | | I | 50 | 5 | 10 |
| Fast growing species | 250 | II | 60 | 4 ∿ 5 | 12 |
| | | III | 140 | 10 | 28 |
| | | I | 50 | 5 | 10 |
| Pines | 250 | II | 60 | 4 ∿ 5 | 12 |
| | | III | 140 | 10 | 28 |
| | | II | 30 | 2 ∿ 3 | 6 |
| Species with longer rotation | | III | 70 | 5 | 14 |
| | | I | 100 | | |
| Total | 600 | II | 150 | | |
| | | III | 350 | | |
| Parcel II | | | | | |
| | | I | 50 | 5 | 10 |
| Fast growing species | 210 | II | 60 | 4 ∿ 5 | 12 |
| | | III | 100 | 7 ∿ 8 | 20 |
| | | I | 50 | 5 | 10 |
| Pines | 260 | II | 60 | 4 ∿ 5 | 12 |
| | | III | 150 | 10 ∿ 11 | 30 |
| | | II | 30 | 2 ∿ 3 | 6 |
| Species with longer species | 130 | III | 100 | 7 ∿ 8 | 20 |
| | | I | 100 | | |
| Total | 600 | II | 150 | | |
| | | III | 350 | | |
| Parcel III | | | | | |
| Fast growing species | 40 | II | 40 | 4 | 8 |
| Pines | 40 | II | 40 | 4 | 8 |
| Species with longer species | 20 | II | 20 | 2 | 4 |
| Total | 100 | II | 100 | | |

Table 3. Necessary Seeds for Phase 1

| | Q'ty of Seeds (per ha) | 1st year | 2nd year | 3rd year |
|---|---|---|---|---|
| Fast Growing Species | | 20 ha | 32 ha | 48 ha |
| Albizia falcata | 160 g | 3.2 kg | 5.2 kg | 7.7 kg |
| Gmelina arborea | 2.8 kg | 56 kg | 90 kg | 135 kg |
| Eucalyptus deglapta | 1 g | 20 g | 32 g | 48 g |
| Leucaena pulverulenta | 280 g | 5.6 kg | 9 | |
| Casuarina equisetifolia | 8 g | 160 g | 256 g | |
| Pines | | 20 ha | 32 ha | 58 ha |
| Pinus kesiya | 125 g | 2.5 kg | 4.0 kg | 7.3 kg |
| P. merukusii | 160 g | 3.2 kg | 5.2 kg | 9.3 kg |
| P. Caribaea | 125 g | 2.5 kg | 4.0 kg | 7.3 kg |
| P. oocarpa | 90 g | 1.8 kg | 2.9 kg | 5.3 kg |
| P. elliottii | 210 g | 4.2 kg | 6.8 kg | 12.2 kg |
| Species with longer rotation | | | 16 ha | 34 ha |
| Tectona grandis | 2.5 kg | | 40 kg | 85 kg |
| Swietenia macrophylla | 5.0 kg | | 80 kg | 170 kg |
| Pterocarpus indicus | 5.0 kg | | 80 kg | 170 kg |
| Eucalyptus degulupta | 1 g | | 16 g | 34 g |
| Cedrela odorata | 100 g | | 1.6 kg | 3.4 kg |

reforestation projects. As mentioned in the Chapter III, however, existing nurseries are not necessarily utilized efficiently, and it is very possible to enlarge those nurseries and to improve nursery practices through the forthcoming technical cooperation.

At three localities selected in three parcels (One in each Parcel), the project will establish three new nurseries of about 9 ha in total, which will be major nurseries for this project. As the nursery work increases later on, the project may look for new localities suitable for nursery. At the same time, however, it is reasonable to improve existing nurseries and to use them in co-operation with existing reforestation projects. The followings are the new localities for nursery.

(Parcel I) The locality is about 3 km far from the dam-side along the road under plan. The area will be about two hectares, and located on a gentle slope along a stream which does not dry up even during dry season. Water can be supplied by damming the stream and pumping up.

(Parcel II) The locality is very close to Talatalan Nursery of Carranglan Reforestation Project. Including the area adjacent to the existing nursery, the size of nursery proposed will be about three hectares. At the upper part of the slope, there is a spring which does not dry up even during dry season. Water can be distributed by storing the water from the spring and pumping.

(Parcel III) The locality is very close to conversion and along the old road from conversion to old Pantabangan. The area is located on a gentle slope and about four hectares. At the upper part of the area, there is a few springs which do not dry up even during dry season. The area proposed is very close to the field office of the Special Project under DNR. Therefore, it is very convenient to keep a close cooperation between both projects – that is,

the Special Project and this Philippine - Japanese Cooperation Project.

According to the yearly plan of afforestation, the new nurseries proposed for Parcels I and II will be established in the first year, and the nursery proposed for Parcel III will be established in the second year. Sketches of the proposed nurseries are shown in Fig. II and the facilities planned at present are as follows:

| (Facilities) | (Parcel I) | (Parcel II) | (Parcel III) |
|---|---|---|---|
| Irrigation System | | | |
| Pump and motor (set) | 1 | 2 | 1 |
| Press tank | 1 | 1 | 1 |
| Water tank | 1 | 2 | 1 |
| Piping | 2 | 2 | 2 |
| Shade-house | 113.4 $m^2$ | 162 $m^2$ | 204 $m^2$ |
| Potting-house | 113.4 $m^2$ | | 204 $m^2$ |
| Green-house | 113.4 $m^2$ | 97.2 $m^2$ | 320.7 $m^2$ |
| Office | 81 $m^2$ | 64.8 $m^2$ | 77.7 $m^2$ |
| Garage | 87.4 $m^2$ | 87.4 $m^2$ | 87.4 $m^2$ |

2) Forest Roads and Soil Conservation

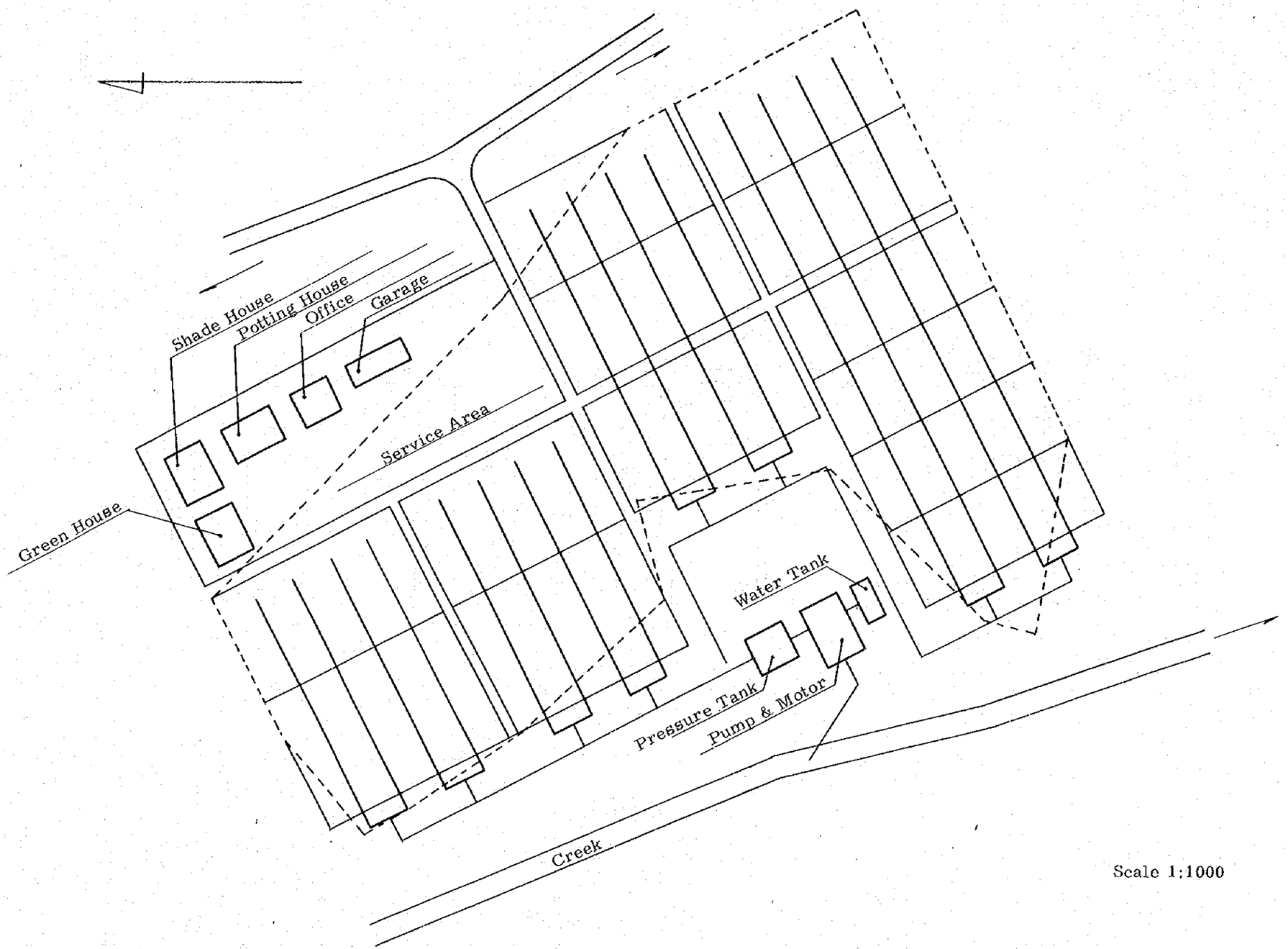
(1) Outline of the plan for forest roads and soil conservation

① Forest road network plan

As described in the Chapter III, there are little facilities like the so-called "forest road" in Pantabangan area. In this survey, the location, scale, and land condition were investigated around the area proposed for trial and experimental plantations. Based on the surveyed results, the following forest road network is proposed in order to implement this project efficiently.

Fig. II-1 PROPOSED NURSERY SITE FOR PARCEL I

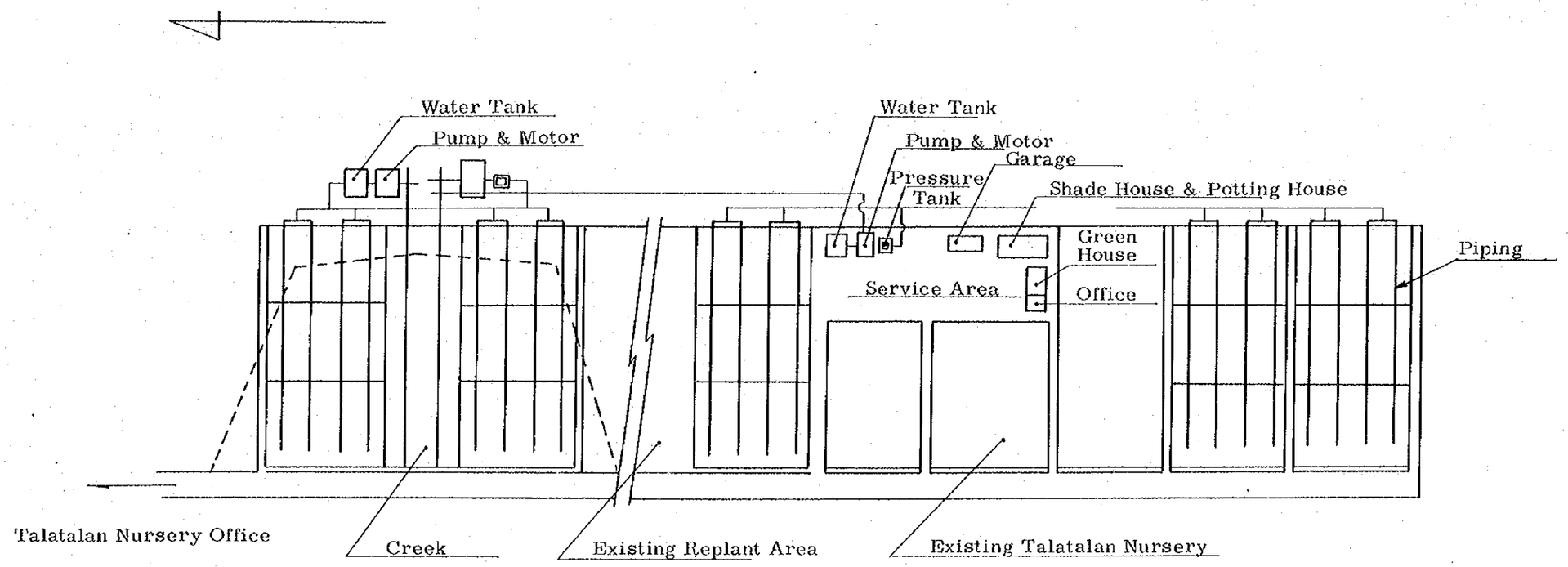
Total Area 2 HA Seedling Bed 1.6 HA




Scale 1:1000

Fig. II-2 PROPOSED NURSERY SITE FOR PARCEL II

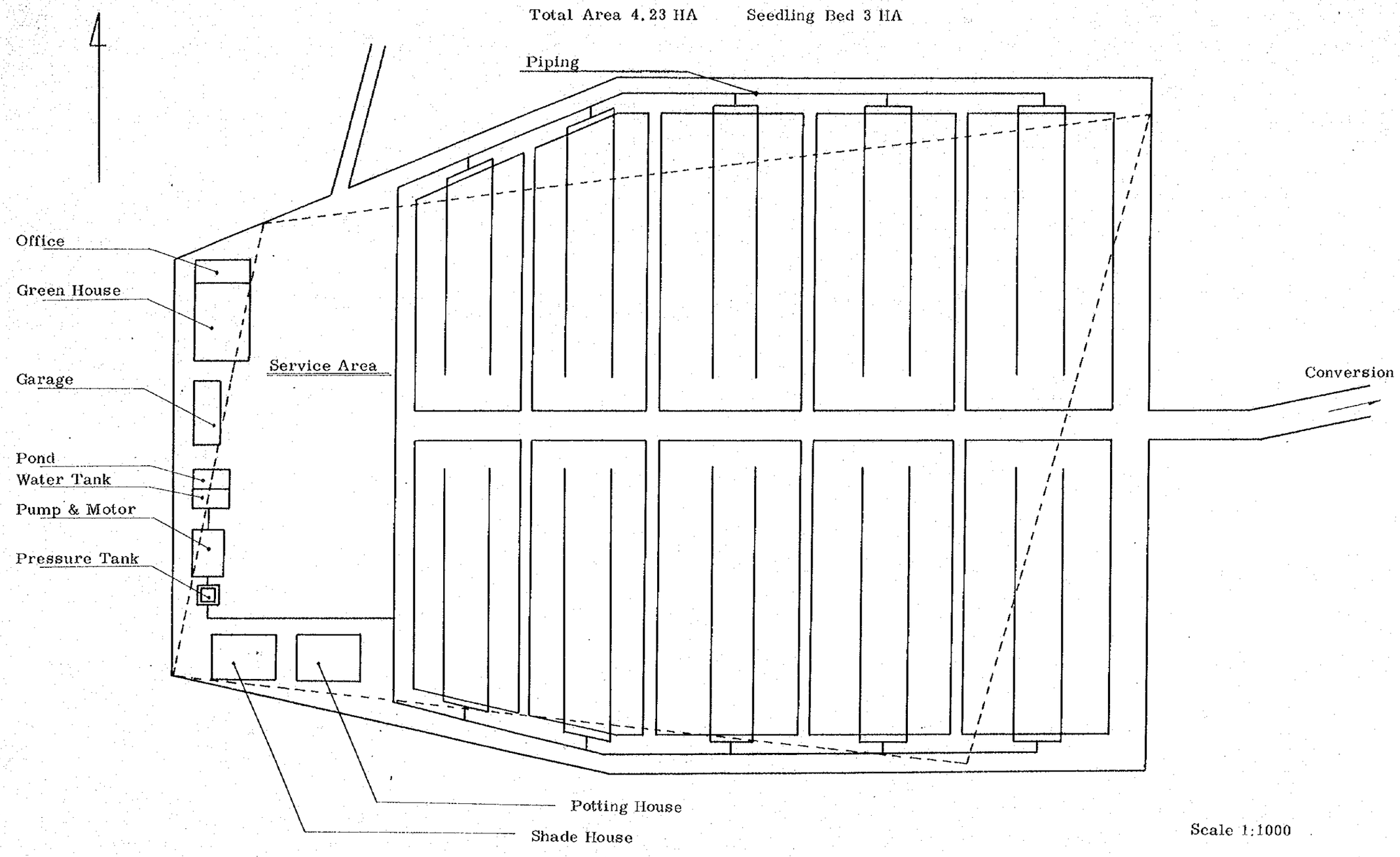
Total Area 3 HA Seedling Bed 1.6 HA




Scale 1:2000

Fig. II-3 PROPOSED NURSERY SITE FOR PARCEL III

Total Area 4.23 HA Seedling Bed 3 HA




Scale 1:1000

(Parcel I)

| | |
|---|---|
| Main forest road: | None |
| Subsidiary forest road: | Three lines amounting to 12,000 m |
| Working forest road: | Ca. 66,000 m in total |

(Parcel II)

| | |
|---|---|
| Main forest road: | Two lines amounting to 24,800 m (including three bridges) |
| Subsidiary forest road: | Ten lines amounting to 31,400 m |
| Working forest road: | Ca. 234,000 m in total |

(Parcel III)

| | |
|---|---|
| Main forest road: | One line amounting to 27,000 m (including seven bridges) |
| Subsidiary forest road: | Twelve lines amounting to 30,200 m |
| Working forest road: | Ca. 180,000 m in total |

(Total in Three Parcels)

| | |
|---|---|
| Main forest road: | Three lines amounting to 51,800 m (including ten bridges) |
| Subsidiary forest road: | Twenty-five lines amounting to 73,600 m |
| Working forest road: | Ca. 480,000 m in total |

The road network is shown in the attached figure III.

(2) Soil conservation plan

The topography in this area is rather gentle and soil is stable, and at present stream works or hillside works do not appear to be required. But some hillside works are necessary to be done at some parts and also in connection with road construction. Details of those works will be described in the section (3).

(2) Planning and construction of forest roads

① Standards of forest roads

Standards of forest roads as a basis of planning should be defined under a careful consideration of topography, geological features, climate, land productivity, labor supply, price of standing trees, etc. Therefore, the study of the standards will be taken as one of the important subjects in this technical co-operation. The study aims at the establishment of more appropriate standards through the progress of this project.

② Directions for planning main forest roads

Main forest roads are the essential basis for forestry management. For the earlier stage, one-lane road will be constructed in order to average the investment of the project and also to minimize the surface erosion resulting from construction. In future, however, the main roads may be widen to two lanes. In designing road body of forest roads, flexible works including the works for surface water flow and seeding and planting works for slopes of hillside and streamside are mainly adopted. In case that the interval between supporting points is longer than ten meters, the second class bridges will be adopted: in those bridges an active load by truck is 14 tons and the width is 4 meters. Those bridges are constructed with single beams to simplify the construction work. Bridges are also constructed with six kinds of interval between supporting points – 10, 12, 14, 16, 18, and 20 m. As the beams longer than 14 m are difficult to transport by trucks, cut beams are connected. R. C. bridges are adopted for the case that the interval between supporting points is shorter than 10 m. In addition, culverts with corrugated pipes laid underground or submerged roads may be adopted.

③ Directions for planning subsidiary forest roads

Subsidiary forest roads are branched from public roads or main forest roads and those are the pivot for working forest roads in the objective area. To minimize the soil quantity to cut, subsidiary forest roads should be planned along a ridge. Most parts of subsidiary roads should be constructed in the same way as main forest roads, but some parts may be constructed using center poles arranged by practical rough survey. In the latter case, the result will vary greatly with skillfulness of bulldozer driver, and so the training of the driver is important for success.

④ Directions for planning working forest roads

Working forest roads are branched along contour lines from main or subsidiary forest roads. Neither survey nor planning is usually done for the construction of working roads. Under the supervision of civil engineers, well-trained workers may indicate center points of the road to be constructed along contour lines, and construct those roads using bulldozer by connecting the indicated center points. For the control of soil erosion, the following works may be effective: To protect the cut and piled surfaces from erosion by improving the techniques of bulldozer driver, and also by seeding and planting works.

(3) Planning and construction of erosion control works

① Stream work

As far as surveyed, the watersheds of rivers and streams in three parcels have not been devastated so seriously. Therefore, erosion control dams for those rivers and streams do not need to be planned for the present. But a constant observation and consideration will be needed, because this sort of

dam may be needed, at some localities in the area in order to protect the area downstream and forest roads from flood which may be caused by forest road construction.

② Hillside work

Along the temporary road for dam construction in the Parcel I, erosion is spreading, and soil and sand are flowing down to the reservoir, which causes unde irable views. Therefore, the following works may be taken for hillside.

Groding:
Each soil has a certain inner friction angle. The angle of silt becomes smaller (than 25°) when loaded with water. To consider this, the top of eroded slope should be rounded and readjusted.

Overflow:
To protect slopes from the erosion by rainfall, rainwater is collected first horizontally and then by U-shaped ditches set radially, and finally conducted to a stream out of the eroded place.

Terracing work:
Terrace of 60 cm wide is constructed for every five meters of slope. The shoulder of terrace is planted with the grasses in Graminaceae like Talahib which may be collected by root in this area. In the center of terrace, ipil-ipil seedlings may be grown by direct seeding.

Seeding and planting work for slope:
Slopes are sprayed or sown with grass seeds mixed with some fertilizer and covered with net for stabilization. Grass seeds may be collected in the area.

Wicker work:

For the geologically unstable slopes, wickers are set horizontally, using bamboo or ipil-ipil produced in this area. The wicker is made as follows; Stems of the abovementioned plants are driven with the interval of 1 to 2 m as log pile. Faggot pannels 30 to 40 cm wide made of their twigs are fixed on those piles.

③ Notes for forest road construction

Introduction of adverse grade:

In case of long ascent, an adverse grade may be inserted for every 200 meters, which is effective in decreasing the velocity of running water in side ditch, in decreasing the erosion activity of water, and eventually in dispersing water on the hillside. The so-called "waving forest road" which has waved vertical composition of slope seems to be effective in erosion control and appropriate water supply to forest trees, together with working forest roads along contour lines.

Conservation of intervening forest:

In case of the establishment of forest roads along a stream, a stand 20 to 30 meters wide should be left between stream and road, whereby to protect rivers and streams from the inflow of soil and sand. The width of remaining stand should be increased in case of steeper slope. Moreover, trees which have grown naturally in the stand should not be cut.

Planting work:

Irrespective of the kind of work, the slopes caused by construction work should be covered with planting for erosion control. For erosion control, Cogon, Samon, Talahib, other appropriate grasses, or ipil-ipil may be hopeful.

Prevention of erosion below drain exit:

The part below the drain exit of crossing ditch, for draining rain

water falling on a hillside or road surface across the forest road, is very easy to be eroded by heavy rain. To protect the part from erosion, old tires filled with rock pieces may be examined.

Submerged road combined with fixing river bed:
In case that forest road crosses a small stream, submerged road may be made of concrete according to the condition. This is also useful in fixing river bed which protects a stream from erosion. A submerged road is designed for water to run under it ordinarily, but to run over it in flooding. Therefore, the damage like washing away of bridge by flood and excavation of bridge bases by water jet may possibly be avoided.

(4) Experimental items

(a) Forest road network:

It is necessary to examine the disposition of forest road network suited for various conditions in the Philippines.

(b) Standards of forest roads:

Main, subsidiary, and working forest roads proposed are constructed to implement this afforestation project. Through the implementation, it is necessary to establish the best condition for cutting and banking slopes under the geological, climatic, and topographic features in this area, and also to establish the appropriate standards of forest roads from the viewpoints of forest tending, price of standing trees, wage, labor situation, etc.

(c) Draining facilities for forest roads:

In view of road maintenance and water conservation, the suitability for this area is compared between the work with more side ditches and the work with less side ditches and

the work with less side ditches and more crossing ditches. For this purpose, several experimental sections of about 300 m each are to be established.

(d) Establishment of modified soil conservation works:

As described in the previous section (3), various soil conservation works should be needed to accomplish this afforestation project. To introduce those works to this area, however, a direct transfer of the techniques developed in Japan may not necessarily be desirable, and various modifications suited for this area must be required. Therefore, the experiments for application are necessary about the items described in the preceding section.

3) Machinery

(1) Machinery for Nursery Practices

As most of the seedlings produced will be dependent mainly on potted seedlings at least for the earlier stage, mechanization may be limited. But to cope with the increased seedling production year by year, the machinery for nursery management and transportation should desirably be introduced.

At the beginning, nurseries may be taken care by machines for forest road construction. But the machines introduced for nursery works should be the type which can be equipped with various operational attachments suitable for the future works. In future, it is probable that the ratio of bare-root seedlings may be increased and seedling beds should be increased.

In raising potted seedlings, the works to collect and move soils and also to transport seedlings occupy a greater part in the nursery practices and so the following kind of machines are desirable to be introduced.

| (Machine) | | (Kind of Work) |
|---|---|---|
| 1t Agricultural wheel type tractor | | |
| | Disk plow | Ploughing |
| | Grader blade | Soil preparation |
| | Broadcaster | Fertilizing |
| | Sprayer | Chemical spraying |
| Fork lift | | Movement and loading of seedling |
| | Bucket | Soil collection |
| 4t Truck | | Seedling transportation |

In the nurseries of the project, not only a routine seedling production but also various experiments for growing seedlings are required. To carry out those experiments, the following facilities and materials are needed.

| | |
|---|---|
| Automatic irrigation system<br>Pump, Motor, Pressure tank, Water tank and Engine generator | Growing seedlings |
| Greenhouse | Germination and growing seedlings |
| Potting house | Potting |
| Shadehouse | Growing seedlings |
| Fertilizers and Chemicals | Promoting seedling growth and protecting seedlings from insects and fungi |

(2) Machinery for planting

Planting works are carried out on the slopes and also require delicacy unlike construction works. Therefore, it is disirable not only to improve the techniques of drivers, but also to introduce a power-turn type (controlled differential mechanism)

of machine rather than clutch and brake type of machine. The power-turn type has a safe performance suitable for the operation on the slopes, which reduces the fearness of the drivers.

Various types of operational machines and attachments can be considered from the viewpoints of topography, planting method, and scale. Mechanization is first considered for ploughing and digging planting holes. Moreover, tractor itself should be chosen in consideration of various attachments for planting. Under those considerations, the following machines are desirable to be introduced.

| (Machine) | (Kind of Work) |
|---|---|
| 5.5t Crowler type tractor | Forest road mending, ground preparation, etc. |
| (Attachments) | |
| Leak dozer | Ground preparation (removing stones) |
| Cultivate Auger | Shallow ploughing and digging |
| Rotary Cutter | Planting holes |
| Rotor Vator | |
| 2.5t Wheel type tractor | As equipped with double winches, this can be used for thinning. |
| (Attachments) | |
| Trailer | Seedling transportation on the slopes |
| Earth Auger | Digging planting holes (on the slopes less than 10°) |
| Handy Auger | Digging planting holes on steep slopes, depressed ground, areas along a stream, etc. |
| Bush Cutter | Bush cleaning |
| Chain Saw | Bush cleaning, especially for forest road construction. This can also be used for thinning. |

(3) Machinery for forest road construction

Both main and subsidiary forest roads proposed are 4.6 m in width. As major work will be an excavation on the slopes, the machines lighter than 15 tons should be advantageous in improving operational efficiency.

Based on the present conditions surveyed and standards of forest roads proposed, it is desirable to introduce the following machines.

| (Machine) | (Kind of Work) |
|---|---|
| 16t Bulldozer (with ripper) | Construction and improvement of forest roads |
| 12t Bulldozer (without ripper) | Subsidiary machines for the work mentioned above, construction of working roads |
| 12t Tractor Shovel | Loading onto dump truck |
| Grader (10t) | Stabilization and maintenance of road surface |
| Road Roller (10t) | Ditto |
| Backhoes (2.5t) | Side ditch work |
| Dump Truck (6t) | |

(4) Machinery for thinning

The time for thinning will be variable according to the performance of plantations, but it should be worthwhile to examine a thinning system beforehand because thinning is the most important operation in the management of artificial plantations. A thinning system varies with species or planting density, as known well.

Some examples of the systems to be examined are as follows: Small scale skidding system with small-sized wheel type tractor, skyline logging system with small-sized yarder, easy skyline logging system with wheel type tractor equipped with double winches, etc.

Assuming the extension of thinning techniques, the following machines may be introduced.

| (Machine) | (Kind of Work) |
|---|---|
| 2.5t Forestry Wheel Type Tractor | |
| Double winches | Skidding |
| TS Type Tree Feller | Felling |
| Yarder | Skidding |
| 6t Truck | Transportation of thinned timber |
| Wire Rope and other | for Skylines |

(5) Machinery for other uses including general management

As described already in connection with the establishment of technical cooperation center and the dispatch of experts, various researches necessary for this afforestation project will be carried out. To meet the activities of experts, therefore, the following machines and facilities need to be introduced.

| | |
|---|---|
| Jeeps | Survey and Communication |
| Motor-boat | ditto |
| Radio communication system | Long distance communication between Manila and the field office |
| | Communication in the area |
| Engine generator | Office use |

| | |
|---|---|
| Apparatus for meteorological observation | Research use |
| Apparatus for water flow survey | ditto |
| Seed stocker and other instruments | ditto |
| Fire-fighting pump and tractor | Fire-fighting |
| Fire-fighting tools | ditto |
| Typewriter, copy machine, etc. | Office use |
| Desk, cabinets, etc. | ditto |
| Machine parts | Maintenance of machines |
| Chainblock and jack | ditto |
| Engine welder, gas cutter, etc. | ditto |

4) Other Relating Matters

(1) Fundamental study on watershed management

As this watershed is one of the most important water sources in the Philippines, appropriate watershed management is required for soil erosion and also for flood control. In addition, nearly half of the total watershed area is the so-called "open land", and most part of the open land has been grazed since many years ago. The greater part of the open land is covered with Cogon, Samon, and Talahib. Those grasses keep soil from erosion at some extent, but surface erosion is observed at the parts where grass vegetation is poor. It is well-known that forests have much better function not only in avoiding soil erosion but also in keeping water within soil layers, as compared with grasslands.

This afforestation project eventually aims at establishing forests on existing grassland for soil and water conservation.

However, the function of forests in soil and water conservation varies greatly with species, stand density, and floor vegetation. Therefore, the function should be examined quantitatively through various experiments necessary for the afforestation mentioned above. This sort of information has been accumulated

for many years in temperate zone, but in tropical rain forests little information is available in the world.

To conduct this sort of experiments, it is necessary to select a few small watersheds which are similar each other in topography, geological features of surface layer, and soils, and to cover those watersheds with different vegetations, e. g. grassland and forest, or coniferous and broad-leaved forests, or to keep them under different land utilizations, e. g. pasturing and non-pasturing. Then, water flow and outflow of soil and gravels are compared among them for five to ten years, and the data are analyzed in relation to rainfall and so on.

During the survey, two small watersheds were tentatively selected near Talatalan. One of them will be afforested and another will be left as it is. Then a small dam for surveying water flow and erosion will be constructed at the mouth of each watershed. To measure such a waterflow, however, one watershed should have at least about 300 ha because it is desirable to avoid the error due to underground waterflow and also to have running water throughout the year. Therefore, it is proposed to construct a dam, as mentioned above, at each mouth of a few small watersheds selected and to survey water flow and outflow of soil and gravels continuously.

In this watershed, logging has already been prohibited for the whole area. But at the places threatened with soil erosion, such as steep slopes, slopes along streams, and over-grazed or repeately burnt areas, a continuous observation should be done about the progress of soil erosion and also about the movement of stones and gravels on the beds of major rivers and streams, especially after heavy rain. The information obtained from such an observation should be useful to analyze the relation between soil consersation and land use, topography, geological features, or rainfall.

(2) Preparation of basic maps and forest sectioning

Various plannings and practical operations in forestry, from planting to logging, should reasonably be based on accurate topographic maps on the scale of 1:50,000 or 1:20,000. In a large area of forest or grassland, site conditions are variable from place to place, and so the land should be divided into small blocks according to the extent of managerial intensiveness. Those blocks are indicated on the map and also in the field, so that planning or practical operations can reasonably be based on those blocks.

As far as inspected, in this area of the Philippines such blocks are hardly adopted and a large area amounting to more than ten thousand ha is usually handled as one unit. Consequently, an actual operation cannot be compared with the planning and a certain point of field cannot precisely be checked on the map. As aerial photographs are available, it is urgently required to prepare basic maps and block maps indicating sectioned units.

In the beginning, the area proposed for pilot forests should be divided into the blocks of about 200 ha according to topography and things to be marked, so that reasonable planning can be done and also the field can accurately be compared with the map prepared. Consecutively, all the area under intensive management should be divided into blocks of 200 to 500 ha and the mountainous area at high elevation should be divided into blocks of 1,000 to 2,000 ha. Based on those blocks, reasonable management can be investigated.

(3) Fire-prevention

Fire-break strips about 15 m wide are established along the border between pilot forest and grassland or other outside. Within the pilot forest, fire-break strips are also established with a target of 6 km/ha. As a rule, fire-break strips are also served as working forest roads. Fire-break strips had better be denuded,

but, at the place in danger of erosion, should be covered with broad-leaved species like ipil-ipil.

Fire-fighting pumps towed by tractors are certainly needed as well as radio communication system between lookout towers and the administrative office.

(4) Protection from diseases, insects, etc.

As far as surveyed, at present neither disease nor insect to be cared about is recognized. But a constant attention is required on the sign of occurrence of diseases or insects in the nurseries and young plantations. If any indication is observed, a diagnosis should be done by the experts in the field concerned. A survey by experts had better be planned for the prediction of damage occurrence.

(5) Measures for the local people

The cooperation of the local people is certainly indispensable to establish plantations, to protect them from fire and other damages, and to grow them up to successful stands. Needless to say that as many local people as possible should be employed for various works related to this afforestation project, it is also necessary to organize the system responsible for the protection of plantations established. Moreover, the measures such as a privilege to sell them fuelwood, organizing a kind of association for forestry works and protection, and a settlement into a forest area combined with Tree-Farming, should be studied. Crop cultivation or pasturing in a forest may also be worthy of trial.

## V-2 Technical Training

The technical training will be given to the staff engaged in this cooperation project in order to implement the project as efficiently as possible. The following is a proposed program for the training. In addition to the training at the Technical Cooperation Center, a number of Philippine personnel will be invited to Japan for necessary training or study tour.

1) Training of Managerial Staff

(1) Planning techniques of afforestation project

(2) Technical and managerial aspects of nursery and plantation works

(3) Techniques for designing and managing forest road and soil conservation works

(4) Techniques for the application of machine power

(5) Techniques to control fire, pest, disease and meteorological damages

2) Training of Technical Staff

(1) Techniques of nursery and plantation works

(2) Techniques of forest road and soil conservation works

(3) Operation and maintenance of machinery

(4) Education on forest protection