

No. 1

BASIC DESIGN STUDY REPORT
ON
THE PROJECT
FOR
THE ESTABLISHMENT OF LARGE-SCALE NURSERY CENTERS
IN THE NORTHEAST OF THAILAND
IN
THE KINGDOM OF THAILAND

JULY 1991

JAPAN INTERNATIONAL COOPERATION AGENCY

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BASIC DESIGN STUDY REPORT ON THE PROJECT FOR THE ESTABLISHMENT OF LARGE-SCALE NURSERY CENTERS IN THE NORTHEAST OF THAILAND IN THE KINGDOM OF THAILAND

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PREFACE

In response to a request from the Government of the Kingdom of Thailand, the Government of Japan decided to conduct a basic design study on the Project for the Establishment of Large-scale Nursery Centers in the Northeast of Thailand and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Thailand a study team headed by Mr. Yoshihiro Koyanagi, Senior Officer on Forest Products Trades, Wood Distribution Division, Forestry Policy Planning Department, Forestry Agency, from January 13, to February 16, 1991.

The team held discussions with the officials concerned of the Government of Thailand, and conducted a field study at the study area. After the team returned to Japan, further studies were made. Then, a mission headed by Mr. Kuniaki Kato, Auditor, Administration Department, Forestry Agency, was sent to Thailand in order to discuss a draft report and the present report was prepared.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

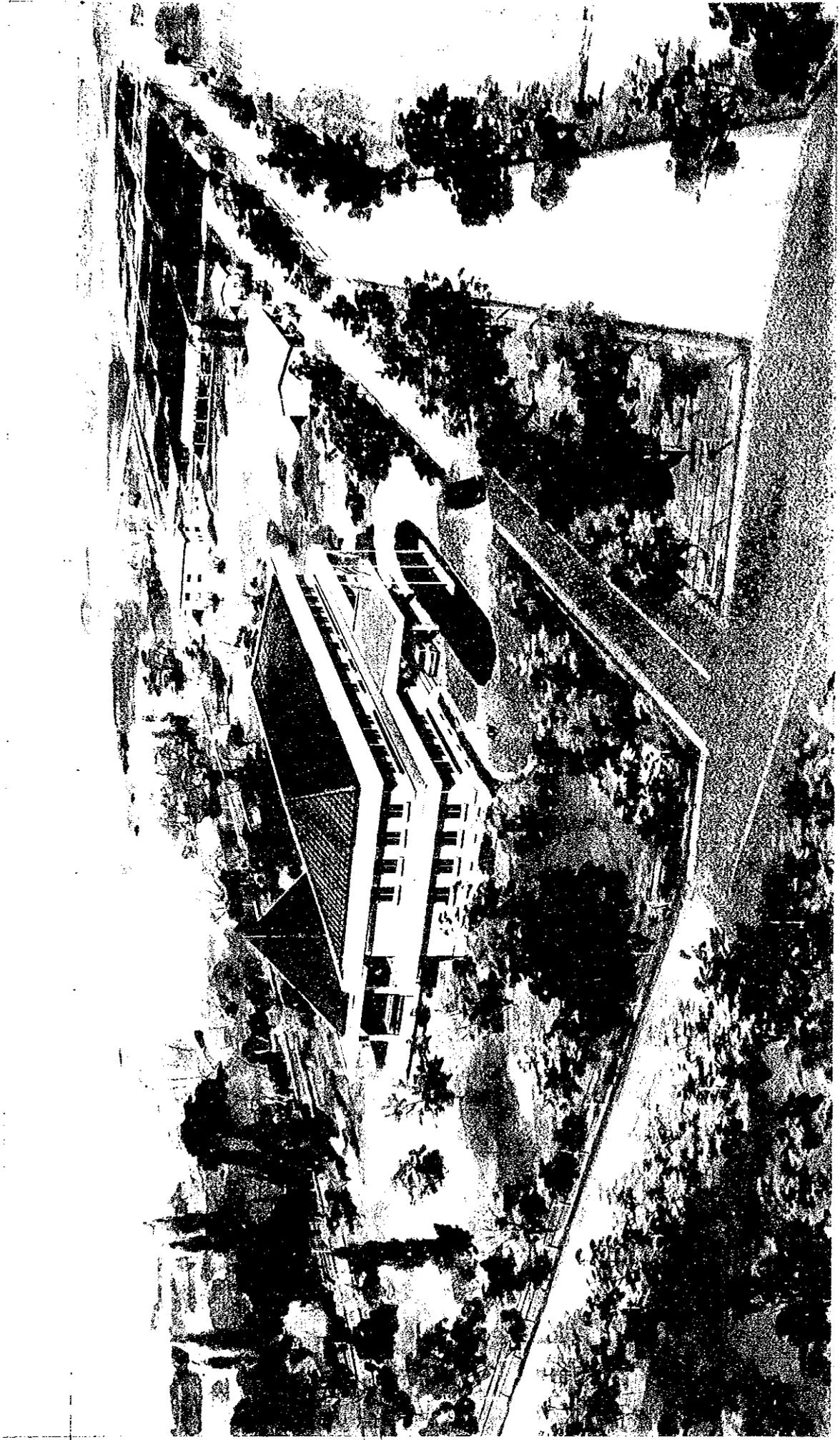
I wish to express my sincere appreciation to the officials concerned of the Government of Thailand for their close cooperation extended to the teams.

July 1991



Kensuke Yanagiya
President

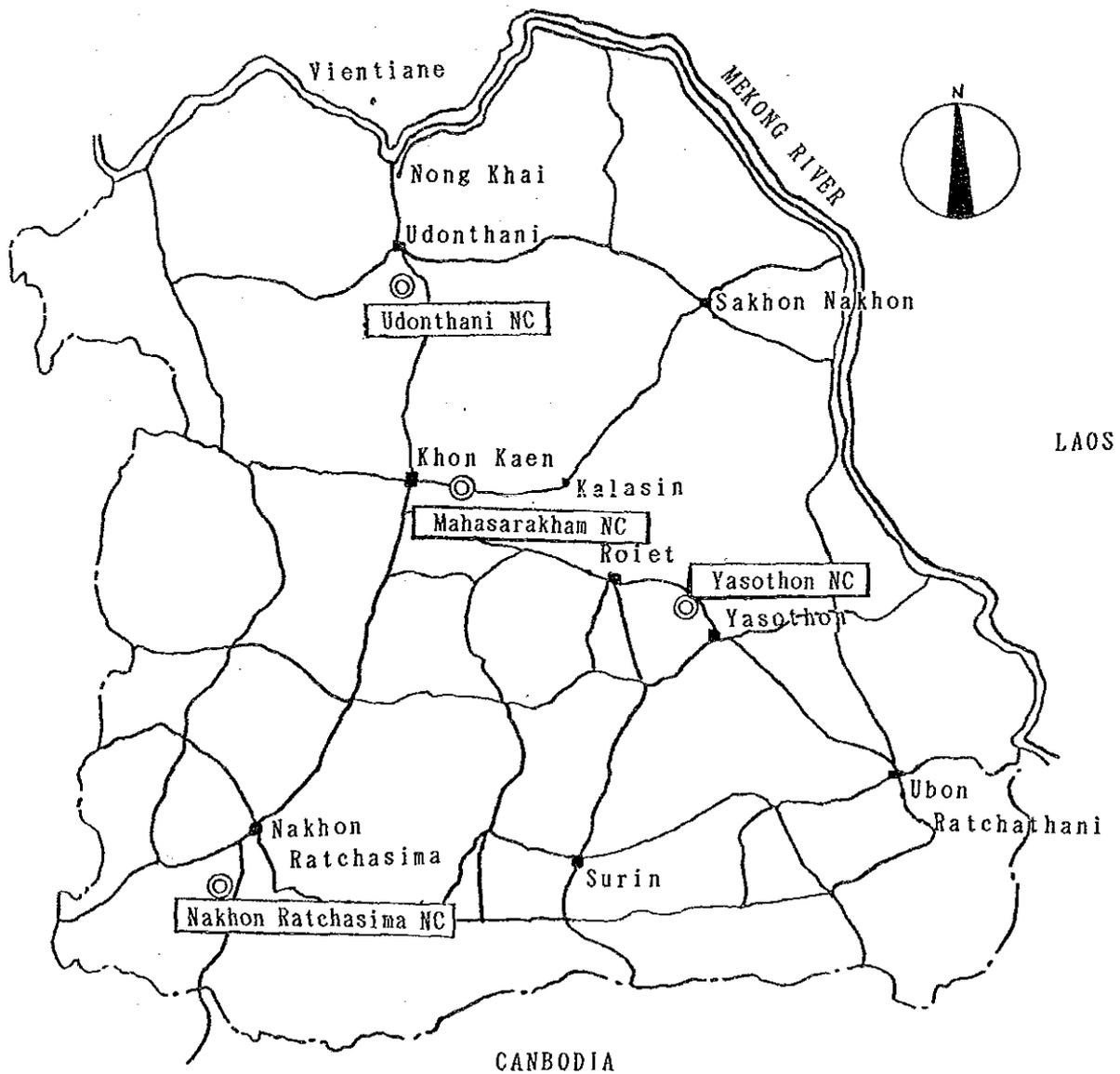
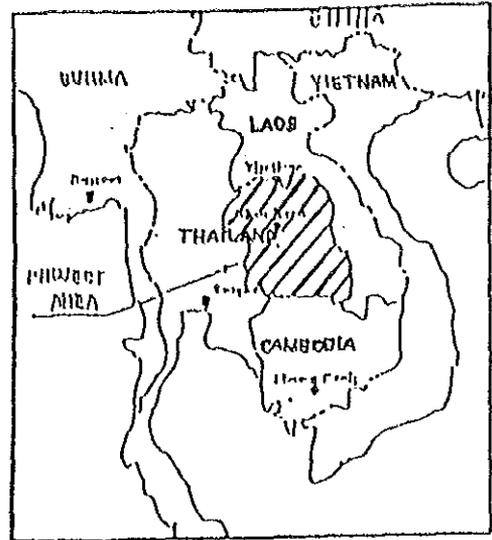
Japan International Cooperation Agency



Perspective Maharashtra Nursery Center

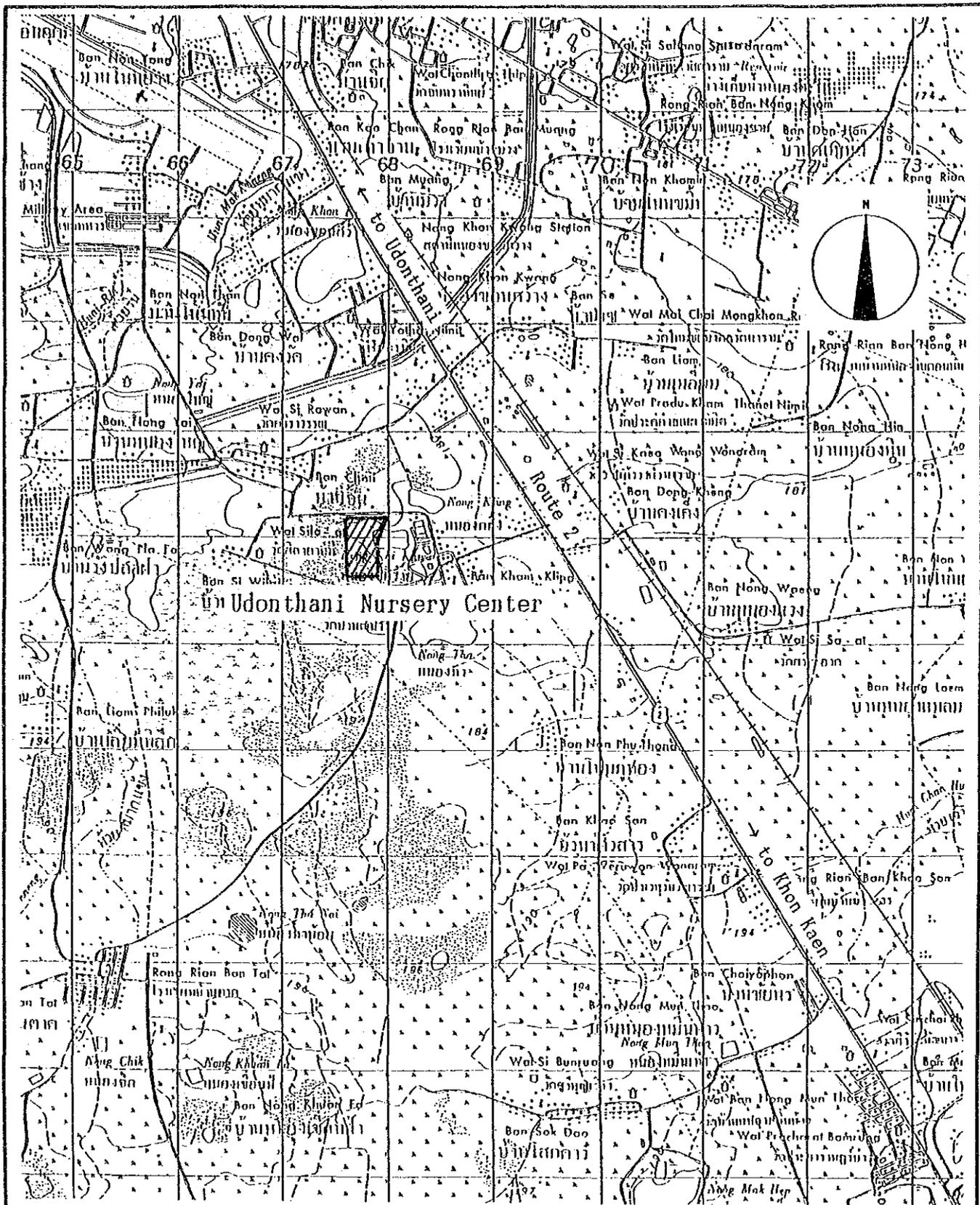
Legend

- ⊙ Nursery Center
- Regional Forest Office
- Main City
- Main Road
- - - Regional Boundary

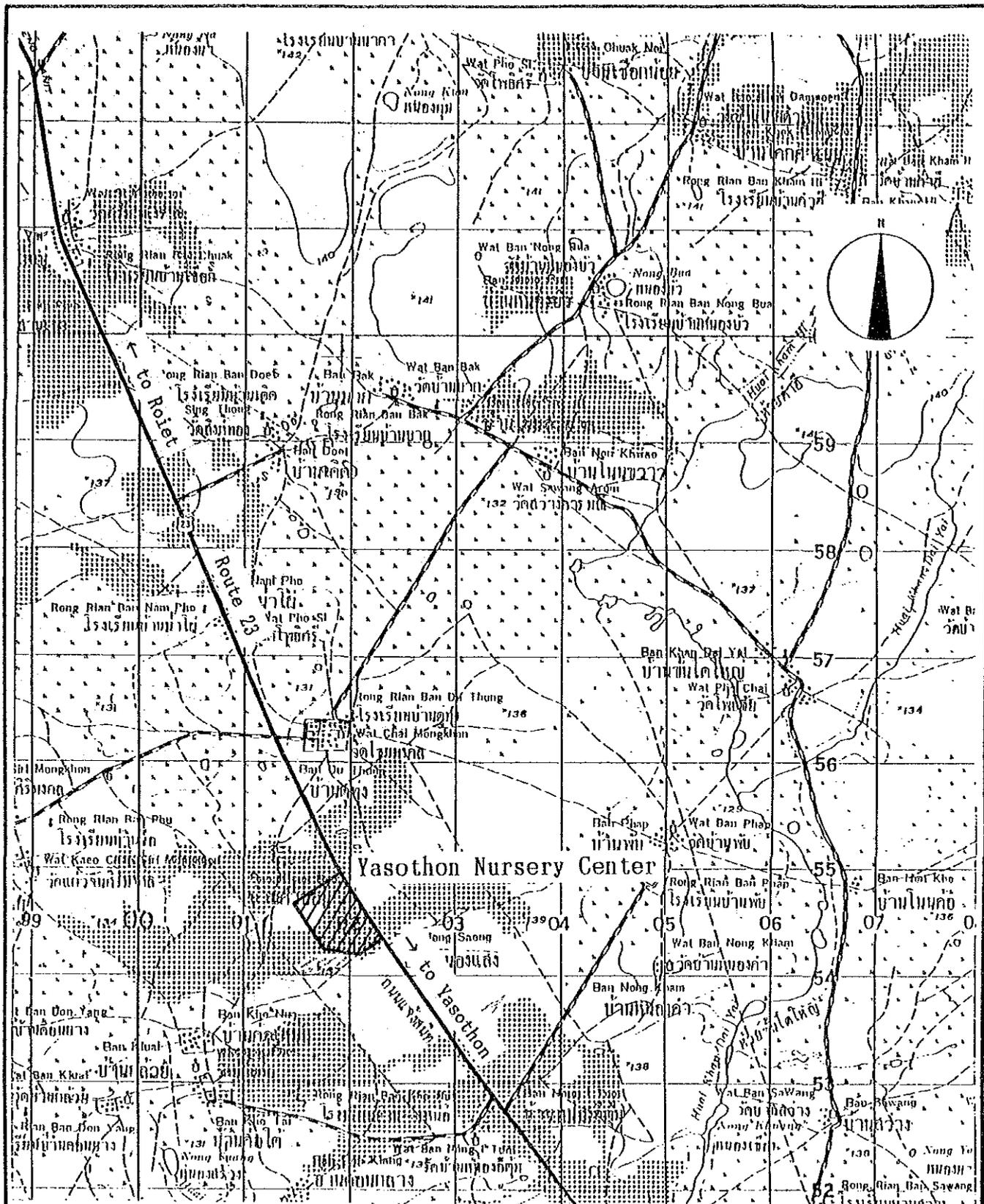


0 50 100 150 km

Location Map 1 Four (4) Large - scale Nursery Centers



Location Map 4 Udonthani Nursery Center



Location Map 5 Yasothon Nursery Center



PROPOSED SITE:MAHASARAKHAM



PROPOSED SITE:NAKHON RATCHASIMA



PROPSOED SITE:UDONTHANI



PROPOSED SITE:YASOTHON

SUMMARY

SUMMARY

The acreage of forest land in Thailand has been seriously on the decrease. This situation is mainly caused by the increasing demand for timber, shifting cultivation and to the expansion of land for subsistence farming due to the rapid economic and population growth in the last two decades. Especially critical is the forest land in the northeastern region of Thailand where forest coverage rate has declined from 42% to 14% within the past 20 years.

According to the National Forest Policy adopted by the government of Thailand on December 3, 1985, the country should maintain 40 % of its total land area as forest area which corresponds to 20.480 million ha. The country, however, has only 27.95 % forested area left at present.

The northeastern region of the country comprises of 17 provinces with a total land area of 16.880 million ha. In accordance with the National Forest Policy 6.752 million ha. should be the forest area. From this point of view, the short fall of the forested area in this region amounting to 4.394 million ha has been indeed a serious overwhelming problem with unfavorable environmental consequences. In order to break through such a situation and to promote the steady progress of reforestation in the region, the government worked out "the Greening of E-san (the Northeast) Project" under "the National Long Plan of Reforestation Program." The main objectives of the Program are as follows;

- 1) Conservation and improvement of natural resources, particularly water, soils and forests,
- 2) Increase in income and employment,
- 3) Improvement in the quality of life of the people.

Under the above - mentioned umbrella plan and project, the government decided to carry out "the Integrated Reforestation and Extension Project" in the northeast of Thailand with the following objectives.

- 1) To prevent natural disaster, improve environmental conditions and up-grade the quality of the people's lives through expansion of reforestation activities and strengthening of social forestry extension.
- 2) To increase the production of good quality seedlings in order to meet the demand of both governmental and private sectors.

3) To establish some demonstration forests and model community forests in order to accelerate tree planting activities in the northeastern Region.

4) To improve reforestation techniques through the training of manpower in both governmental and private sectors, the latter also enlisting "grassroots' level" workers including women.

As mentioned above, reforestation in the northeastern region is very important and needs to be done quickly. The government of Thailand, therefore, requested the government of Japan to extend technical cooperation, grant aid and to dispatch Japan Overseas Cooperation Volunteers (JOCV) in order to promote the implementation of the Integrated Reforestation and Extension Project in the northeast of Thailand

In response to the request, the Government of Japan, adjudging that the Project will contribute not only towards regional development and mitigation of natural conditions in the northeastern Thailand, (where natural and social conditions are particularly rigorous among the regions of Thailand) but also towards global-scale environmental conservation, decided to conduct a preliminary survey on the Integrated Reforestations and Extension Project in the northeast of Thailand, and entrusted the survey to the Japan International Cooperation Agency (JICA). JICA sent to Thailand the survey team for 17 days between September 13 and 29, 1990 to confirm the background and particulars of the request, the administration system of the Project, the effect of cooperation and the feasibility of implementing cooperation.

Based on the results of the survey, JICA decided to implement the Basic Design Study on the Project for the Establishment of Large-scale Nursery Centers in the Northeast of Thailand, and sent the study team for 35 days between January 13 and February 16, 1991. The Team, using the results obtained by the preliminary survey team as a basis, conducted study activities such as discussions on the scope of the Project, confirmation of the situation of the Project in the national or sectoral development plan, study on the appropriateness, necessity and priority of the Project, confirmation of maintenance and management system of the Project, survey of Project sites, study on the scale and contents of the Project, etc.

The components of the Project requested by the Government of Thailand are as follows;

- Main Building
Mahasarakham Nursery Center
 - Main Office and Training Building
 Nakhon Ratchasima, Udonthani and Yasothon Nursery Centers
 - Main Office Building with Training Part
- Dormitory
Four (4) Nursery Centers
- Facilities
Open Nursery, Germination Nursery (Closed Nursery), Knockdown Nursery, Glass House, Storage, Potting House, Compost House, Work-shop, Garage, Cafeteria, Rest House, Other Facilities (Water Supply System, Generator House)
- Equipment and Tools
Equipment and Tools for Nursery Work, Demonstration Plantation, Transportation, Administration, Laboratory for Mass-production, Extension and Training.

The executing agency of the Project is the Royal Forest Department (RFD). Preparing the operational structure and plans of activities for the Integrated Reforestation and Extension Project in the Northeast of Thailand, RFD will implement effectively the production and distribution of seedlings, establishment of demonstration plantation, extension and training by the establishment of Large-scale Nursery Centers.

Judging from the point of view that the four (4) Large-scale Nursery Centers will play an important role in thrusting reforestation in the northeastern region, the pertinency and necessity of the Project is deemed to be imperative.

The particulars of the facilities and the equipment and tools are enormous in quantity since the Project sites spread widely around the four areas of the northeastern region, and the various facilities are needed in sets of fours. Accordingly, to attain the objectives of the Integrated Reforestation and Extension Project, particulars are studied while taking into consideration the necessity and the minimum to fulfill the functions of the Nursery Centers smoothly, and more importantly, to make sure they fall within the frame work of Japan's grant aid program.

As a result of the study, the outline of facilities and equipment are as follows;

1) Facility

◦ Administration Facilities

- Main Office and Training Building
- Workshop
- Garage
- Generator House
- Oil Tank Base

◦ Nursery Facilities

- Closed Nursery/Germination House
- Vinyl House (Only for Mahasarakham Nursery Center)
- Open Nursery
- Potting House
- Compost House
- Storage House
- Seed Solar Dryer

◦ Other Appurtenant Facilities

- Pump Station
- Water Distribution Tank
- Water Tank
- Work Road
- Access Road
- Drainage Facilities

2) Equipment

◦ Equipment and Tools

- For Nursery; seedling container, potting stand (Only for Mahasarakham Nursery Center), knock-down nursery, u-shape shed net, etc..
- For Plantation; back-pack pump, VHF/FM transceiver set, etc..
- For Administration and Extension; automatic copying machine, facsimile machine, single side band transceiver, personal microcomputer set, etc..
- For Workshop; car washer, part washing stand, garage jack

– For Laboratory

- Nursery Laboratory (Only for Mahasarakham Nursery Center);
thermostic germinator (only for Mahasarakham Nursery Center), seed
divider and others
- Plantation Laboratory; field PH meter, balance set(only for
Mahasarakham Nursery Center) an oven (only for Mahasarakham
Nursery Center), furnace (only for Mahasarakham Nursery Center),
etc..
- Pathology Laboratory (Only for Mahasarakham Nursery Center);
clean bench, incubator, autoclave, compounding microscope, knife
sharpener, etc..
- Extension and Training Laboratory (Only for Mahasarakham Nursery
Center); camera, slide projector system, audio-system etc..
- Glass Ware;

◦ Machinery

- Heavy Machine; wheel loader, truck for transportation (with crane &
without crane), bulldozer (large), hydraulic excavator, dump truck, water
tank truck and farm tractor
- Vehicle; pick-up truck (small & 4WD) and motorcycle (for each Nursery
Center), station wagon and microbus (only for Mahasarakham Nursery
Center)
- Other Machine; seed scarifier machine, coconut husk crusher, soil
sieving machine, soil mixture machine

The Large-scale Nursery Centers in the Northeast of Thailand established under the Project are to be used as bases for the implementation of the Integrated Reforestation and Extension Project in the production and distribution of seedlings, the establishment of demonstration plantation, extension and training. Through these activities, the Nursery Centers are destined to contribute to the solution of not only the problem of the lack of timber and fuel wood supplies, but also the problem of poverty in the rural areas. The project is therefore deemed very vital and significant.

The following suggestions are presented with a view to expedite the implementation of the Project and ensure the smooth and effective operation of the Nursery Centers.

1) As the Project will be implemented in accordance with the principles of Japan's grant aid program, there is need to complete the construction works within a definite period of time. It is essential, therefore, that necessary procedures for the exchange of notes, consultant agreement, construction contract and other contracts related to the procurement of equipment shall be completed promptly.

2) It is necessary that the Thai side shall complete its responsible works, particularly the site preparation work and the power line installation work before the Japanese side starts its construction work.

3) In order to implement smoothly and effectively the activities of the Nursery Centers, it is necessary to secure an ample budget and sufficient personnel including the required lecturers.

4) Although a dormitory for trainees in each Nursery Center is indispensable to the training which is one of the important activities of the Integrated Reforestation and Extension Project in the Northeast of Thailand, the construction of such a facility will not be included to the Project according to the policy of Japan's Grant Aid. It is desirable, therefore, that the Thai side should secure its own budget for the construction of these dormitories and complete the construction work in parallel with the implementation of the Project.

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CHAPTER 1
INTRODUCTION

CHAPTER 1 INTRODUCTION

The Government of the Kingdom of Thailand requested the Government of Japan to assist the implementation of the Integrated Reforestation and Extension Project in the Northeast of Thailand. This project qualifies in the fulfillment of the emphases of the development cooperation in the 1990s, such as people's participation, promotion of the role of women in development, alleviation of poverty and involvement of Non-Governmental organizations from the planning stage. The highest priority is attached to the project by the Government of the Kingdom of Thailand in its national economic and social development planning, and the project activities will be closely meshed with other projects in the framework of a regional program popularly known as the Greening of E-San.

Accordingly, the following would be the objectives of the Integrated Reforestation and Extension Project in the Northeast of Thailand.

- 1) To prevent natural disasters, improve environmental conditions and up-grade the quality of people's lives through expansion of reforestation activities and strengthening of social forestry extension.
- 2) To increase the production of good quality seedlings in order to meet the demand of both governmental and private sectors.
- 3) To establish demonstration forests and model community forests in order to accelerate tree planting activities in the Northeast Region.
- 4) To improve reforestation techniques through the training of both governmental and private man power, the latter also enlisting "grass-roots' level" workers including women.

The Integrated Reforestation and Extension Project in the Northeast of Thailand requires the assistance of Grant aid, Technical Cooperation and Japan Overseas Cooperation Volunteers (JOCV).

In response to the request, the Government of Japan decided to conduct a Preliminary Survey on the project and entrusted the survey to the Japan International Cooperation Agency (JICA). JICA sent to Thailand the survey team headed by Mr. Katsura Watanabe, JICA Forest Specialist, for 17 days from September 13 to 29, 1990 to confirm the background and components of the request, the administration system of the project, the effects of cooperation and the feasibility of implementing cooperation.

Based on the results of the Preliminary Survey for the project, JICA decided to implement the Basic Design Study on the Project for the Establishment of Large-scale Nursery Centers in the Northeast of Thailand and sent the study team, headed by Mr. Yoshihiro Koyanagi, Senior Officer on Forest Products Trade, Wood distribution division, Forest Policy Planning Department, Forestry Agency, from January 13 to February 16, 1991.

The team conducted the following activities based on the results obtained by the preliminary survey team.

- 1) Discussions on the scope of the Project
- 2) Confirmation of the situation of the Project in the National Development Plan and Sectoral Development Plan
- 3) Study on the appropriateness, necessity and priority of the Project (buildings, nurseries, equipment and tools)
- 4) Confirmation and clarification of the contents of related projects, if any.
- 5) Confirmation of maintenance and management system of the Project (administration plan, operation plan, budgetary plan, staff plan etc..)
- 6) Survey of the Project site (area, weather, humidity, soil, etc..)
- 7) Study on the scale and contents of the Project (buildings, nurseries, equipment and tools)
- 8) Collection and analysis of data for the Basic Design
- 9) Study on local construction conditions

This report comprises the compilation of the results of the analyses undertaken in Japan on the basis of the findings of the study team. The members of the study team, the survey schedule, the list of the members concerning parties in the recipient country and the minutes of discussions are included in the Appendix attached at the end of this booklet.

CHAPTER 2

BACKGROUND OF THE PROJECT

CHAPTER 2 BACKGROUND OF THE PROJECT

2-1 Background of the Project

In Thailand, the acreage of forest land has seriously decreased. This situation is ascribable mainly to the increasing demand for timber and to the extension of land for subsistence farming, shifting cultivation, etc. due to the rapid economic and population growth in the last two decades. Especially critical is the land in the northeastern region of Thailand where forest coverage rate has declined from 42% to 14% within the past 20 years.

According to the National Forest Policy adopted by the government of Thailand on December 3, 1985, Thailand should maintain 40% of its total land area as forest area which corresponds to 20.480 million ha. The country, however, has only 27.95% forested area left at present.

The northeastern region of the country consisting of 17 provinces with a total land area of 16.880 million ha should have a forest area of about 6.752 million ha in accordance with the National Forest Policy. However, current inventory statistics indicated that the northeastern region of the country has only 2.358 million ha of forested area which was 7.100 million ha in 1961. Therefore, the shortfall of forest area in the northeastern region amounting to 4.394 million ha has indeed been a serious overwhelming problem with unfavorable environmental consequences.

Geographically, the northeastern region of Thailand is a rolling plateau with mostly poor, highly leached podzolic soils and lateritic soils with substantial saline soil condition. The agricultural productivity of this region is generally the lowest of the country. Soil salinity, now a major problem in the Northeast, can be directly linked to the loss of forest cover due to population increase and expansion of agricultural activities.

Harsh environmental conditions prevail in most areas of the Northeastern region which include drought in the dry season and flood in the rainy season. Immediate actions for the restoration of the environment have to be implemented and the creation of a vegetation cover in the region will be prepared with a long-term effect in mind.

The master plan envisaged at this stage is called "The Royal Initiatives to Develop the Northeast" or popularly known as the Greening of E-san Project. It

is arranged under the National Long Plan of Reforestation Program. The three main objectives of the Greening E-san Project are as follows:

- Conservation and improvement of natural resources, particularly water, soils and forests.
- Increase in incomes and employment
- Improvement in the quality of life of the people

According to the National economic and Social Development Plan, the reforestation program will be operated by the State, State Enterprise and the Private sector in order to increase the forest land in Thailand up to 7.184 million ha. within 30 years beginning from 1991. The reforestation area of 1.32 million ha. will be established by the government or state mainly through the Royal Forest Department and Ministry of Defense. The forestation area of 0.528 million ha. will be established by the State Enterprise mainly through the Forest Industrial Organization and Thai Plywood Company for the purpose of producing forests or industries emphasizing on teak and fast growing tree species. Planting and tending operation by private sectors (village, farmer, temple, school, private owner, etc.) for the purpose of industries, community and other uses are about 5.336 million ha. emphasizing on wood lot community plantation, local industrial plantation, road-side planting, sustaining planting in the upcountry and Agro-forestry planting.

The Royal Forest Department (RFD) has taken its part as the core of the government agency in the National Long Plan of Reforestation Program and the Greening of E-san Project. Under the two above mentioned umbrella plan and project, the Royal Forest Department (RFD) is responsible in carrying out the Integrated Reforestation and Extension Project in the Northeast of Thailand.

In this background, the government of the Kingdom of Thailand has requested Japan to provide Grant Aid, Project-type Technical Cooperation and Japan Overseas Cooperation Volunteers (JOCV) for the implementation of the Integrated Reforestation and Extension Project in the Northeast of Thailand.

2-2 Outline of the Request

The components of the Project requested by the government of the Kingdom of Thailand are;

(1) Main Building

Mahasarakham Nursery Center

- **Main Office and Training Building**

Nakhon Ratchasima, Udonthani and Yasothon Nursery Centers

- **Main Office building with Training Part**

(2) Dormitory

Four (4) Nursery Centers

(3) Facilities

Open Nursery, Germination Nursery (Closed Nursery), Knock-down Nursery, Glass House, Storage, Potting House, Compost House, Work-shop, Garage, Cafeteria, Rest House, Other Facilities (water Supply System, Generator House)

(4) Equipment and Tools

Equipment and Tools for Nursery Work, Demonstration Plantation, Transportation, Administration, Laboratory for Mass-production, Extension and Training

CHAPTER 3

OUTLINE OF THE PROJECT

CHAPTER 3 OUTLINE OF THE PROJECT

3-1 Objective

The objective of the Project is to establish four (4) Large-scale Nursery Centers in the Northeast of Thailand in order to effectively achieve the following objectives of the Integrated Reforestation and Extension Project in the Northeast of Thailand.

- 1) To prevent natural disasters, improve environmental conditions and up-grade the quality of the people's lives through expansion of reforestation activities and strengthening of social forestry extension.
- 2) To increase the production of good quality seedlings in order to meet the demand of both governmental and private sectors.
- 3) To establish demonstration forests and model community forests in order to accelerate tree planting activities in the Northeast Region.
- 4) To improve reforestation techniques through the training of both governmental and private man power, the latter also enlisting "grass-roots' level" workers including women.

3-2 Study and Examination on the Request

3-2-1 Study on the Pertinency and Necessity of the Project

Based on the activities of the Integrated Reforestation and Extension Project in the Northeast of Thailand such as the production and distribution of seedlings, the establishment of demonstration plantation, extension and training, four Large-scale Nursery Centers established by the Project play an important role in thrusting reforestation of the Northeastern region. From this point of view, the pertinency and necessity of the Project is deemed to be imperative.

Furthermore, the nursery scale, the location of the four Nursery Centers and the main base of these Centers that are considered suitable are as follows;

1) Nursery scale

According to the five year plan of the Integrated Reforestation and Extension Project (1991-1995), the largest number of annual production of seedlings from 1993 to 1995 is 29 million, which can be produced mainly in the four Large-scale Nursery Centers. Since the target of seedling production per one Nursery Center will be 5 million, the nursery scale would be suitable.

2) Location of four Nursery Centers

The locations of the four Nursery Centers are considered suitable because of their strategic locations on the road networks of the whole northeastern region.

3) Main base of four Nursery Centers

Since the activities of the Integrated Reforestation and Extension Project cover all of the areas in the Northeast of Thailand, it is necessary to set the main base of the four Nursery Centers in the central part of the area and make it function as the headquarters. The plan, therefore, which is to select Mahasarakham Nursery Center near Khon Kaen as the main base is reasonable.

3-2-2 Study on the Implementation Management Plan

The budget related to the Integrated Reforestation and Extension Project, which is the matrix of the Project, is to be secured as the special appropriation of the government while the five year plan given below has already been prepared by the Royal Forest Department (RFD). The 1991 budget (put into effect from September 1990) has already been secured and the project is already under implementation.

Table 3-2-1 Thai Side Budget for Implementation of the Project

Unit : 1,000 Bahts

Items	Year					Total
	1991	1992	1993	1994	1995	
1. Seedling Production	4,440	10,350	33,350	33,350	33,350	114,840
2. Demonstration Plantation	3,720	14,880	22,320	22,320	22,320	85,560
3. Tending of Plantation	-	680	3,400	7,480	11,560	23,120
4. Forest Road Construction	-	7,564.8	11,347.2	11,374.2	11,374.2	41,660.4
5. Fire Line Construction	-	40	200	440	680	1,360
6. Construction of official house, labour house etc.	14,837.3	4,475.2	6,427.7	4,154	2,184	32,078.2
7. Staff Official	3,234.8	10,429.8	19,147.4	22,939.64	22,939.64	78,691.3
8. Material, oil, fuel	2,349	4,847.44	4,847.44	5,781.18	5,781.18	23,606.2
9. Others	500	630	150	170	170	1,620
Total	29,081.1	53,897.24	101,189.74	107,982.02	110,322.02	402,482.1

As the Royal Forestry Department's budget for 1990 totaled 2,791,000,000 bahts, which represents a growth of 160% over the preceding year's figures, Thailand in recent years may well be taken as indicating a positive stance towards nationwide reforestation. However, it is important to secure the budget for the implementation of the Project.

3-2-3 Study on the Facilities, Equipment and Tools

The facilities, equipment and tools requested are bound to become enormous in quantity since the Project sites spread widely around the four regions in the northeast of Thailand, and the various facilities are needed in sets of fours.

Accordingly, to attain the objectives of the Integrated Reforestation and Extension Project the components will be studied carefully in order to fulfill the necessary and minimum range of allowing the four Nursery Centers to perform their functions smoothly considering the capacity of the executing agency and the framework of Japan's grant aid cooperation system.

(1) Facilities

Maharakham Nursery Center is to serve as an important base for controlling the plans and implementation of seedling production and reforestation in the entire northeastern area of Thailand and also for providing training and extension activities. For this reason, the basic facilities needed for such activities must be established.

However, as facilities that can be provided by the Thai side for the nursery centers including the other three will be excluded, facilities such as dormitory for the trainees, rest house for nursery workers and cafeteria for the three Nursery Centers other than Maharakham Nursery Center will become the targets.

With regards to the facilities of the office rooms, laboratory, meeting room, reception booth, garage, storage, etc., combinations, scale-downs or abridgments will be made in order to keep the maintenance costs as low as possible by conducting a relative study of details.

The nursery facilities such as sprinklers and pulley systems of opening and closing sunshade nets intended for the open nursery will not be used as they are subject to frequent troubles and are difficult to maintain. It is also considered pertinent to establish a vinyl house only at Maharakham Nursery Center for the reason that cutting production leans strongly towards the objective of technical development.

(2) Equipment

It is planned that the equipment to be supplied in the Project is basically necessary for the various activities of the four Nursery Centers. The policy for the equipment supply plan is described as follows;

- The equipment that can be supplied by the Thai side is excluded.
- The equipment shall be planned to be used for multi-purpose as much as possible; i.e. common use and substitutional use of the equipment are to be promoted.
- O&M (operation and maintenance) cost of the equipment shall be carefully examined in order to avoid insufficient use of the equipment.
- The laboratory equipment shall be limited to testing purposes required for the implementation of the Project.
- Upon consideration of the executing plan of the Thai side, the equipment for the demonstration plantation is planned to be within the minimum level.

In addition to these, Mahasarakham Nursery Center, as the main center among the four Nursery Centers, shall be provided with more equipment and tools for the nursery laboratory, plantation laboratory, pathology laboratory, and extension and training laboratory than the other three Nursery Centers.

The study and examination results of the equipment are described as follows;

1) Equipment and Tools

- For Nursery

The following items shall be of local components,

- camping tent, boot, nylon rope, safety helmet, pole pruner, leather glove, seed collection sheet and bag, tag and seal, whet stone, rake, shovel, trolley, rubber square tray, portable floor, hole maker for plastic bag, fertilizer.

Double-strut sectional ladder is substituted with single-strut sectional ladder. Binoculars and cameras with accessories are substituted with those of the other section. Potting stand is only provided for Mahasarakham Nursery Center.

- For Plantation

Swatters and rakes shall be local components. Hagahypsometers and altimeters are deemed unnecessary considering the condition of the proposed demonstration plantation sites. Seedling containers shall be substituted with those of the nursery. S-mite set for forest road construction shall be substituted with the breaker of hydraulic excavator.

- For Administration and Extension

Electronic pocket calculators and the tables and chairs for field extension are to be local components. The offset press and the cylinder-processing machine shall be substituted with the automatic copy machine. Board cutter seems to be for professional use and not a necessity. Video projectors for the four Nursery Centers are substituted with television sets.

- For Workshop

The equipment and tools requested, except for rammer (local component), are for preventive maintenance use and are necessary for the Project. In addition, the water tank and the pump for car washers and part washing stand, and fire extinguisher for fuel and oil stations shall be provided.

- For Laboratory

Based on the above-mentioned policy, indispensable equipment and tools are provided for the laboratory for the Project implementation. Therefore, instruments for tissue culture are excluded.

2) Machinery

The common and substitutional use of the machinery not only for the nursery and plantation activities but also for extension and training is highly promoted due to O & M cost. Therefore, in order to promote common and substitutional use, the following addition of the attachment and change in the type of machinery are considered.

- Heavy Machine

Type of Machine	Description
- Bulldozer (small)	Substituted with bulldozer (large)
- Wheel Loader (large)	Substituted with wheel loader (small) with a back-hoe as an attachment for the excavation of soil for seedling pots.
- Truck for Seed Collection	Substituted with pick-up truck and single-strut sectional ladder
- Farm Tractor (small)	Substituted with farm tractor (large)
- Shovel Dozer	Substituted with hydraulic excavator
- Compactor	Substituted with bulldozer (large)
- Motor Grader	Substituted with bulldozer (large)

- Vehicle

Type of Vehicle	Description
- 60 Seat Air bus	Substituted with two minibuses (25 seats) which are changed from the original specification of 15 seats.
- Vehicle (car)	Substituted with a station wagon

3-2-4 Study on the Necessity of Technical Cooperation

The necessity of technical cooperation to the Integrated Reforestation and Extension Project in the Northeast of Thailand has been studied and identified by the preliminary survey team sent by the Japan International Agency to the Kingdom of Thailand in September 1990.

3-2-5 Basic Policy of Cooperation Implementation

Based on the above mentioned study and examination, the implementation of the Project is adjudged pertinent since it is necessary for the effective implementation of the Integrated Reforestation and Extension Project in the Northeast of Thailand. The recipient country is confirmed to be capable of implementing the Project since the effect of the Project is compatible with the Grant Aid Cooperation system and since important results can be expected from the Technical Cooperation planned in connection with the Project. Accordingly, the outline of the Project is examined and basic design is executed upon the premise of the Japan's Grant Aid Cooperation.

3-3 Project Description

3-3-1 Executing Agency and Operational Structure

The Executing Agency of the Project, whose matrix is the Integrated Reforestation and Extension Project in the Northeast of Thailand, is the Royal Forest Department (RFD). The Operational Structure of the Project is shown in the following (Fig. 3-3-1, 3-3-2, Table 3-3-1 and 3-3-2).

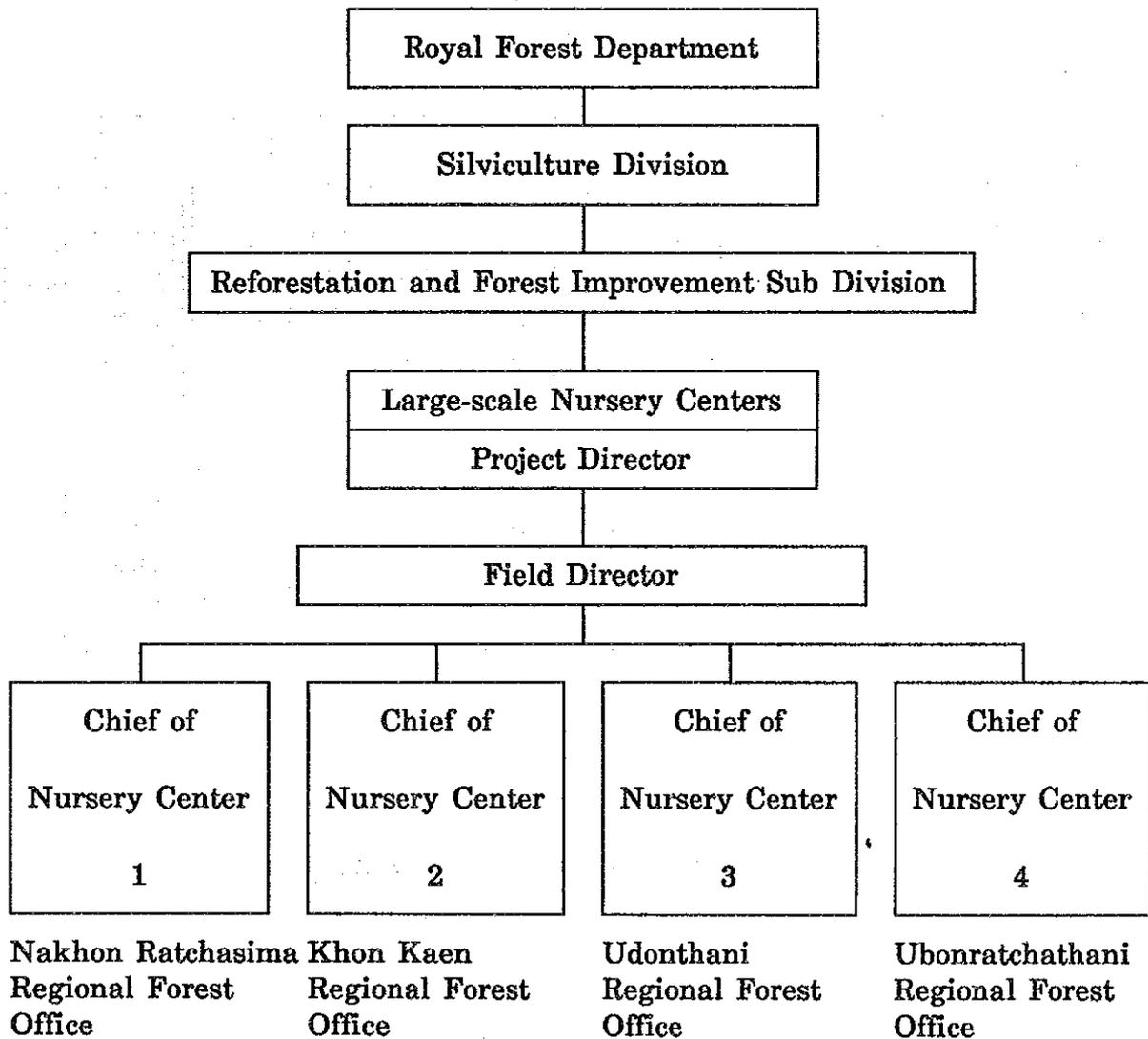


Fig. 3-3-1 Organization Chart of the Nursery Center

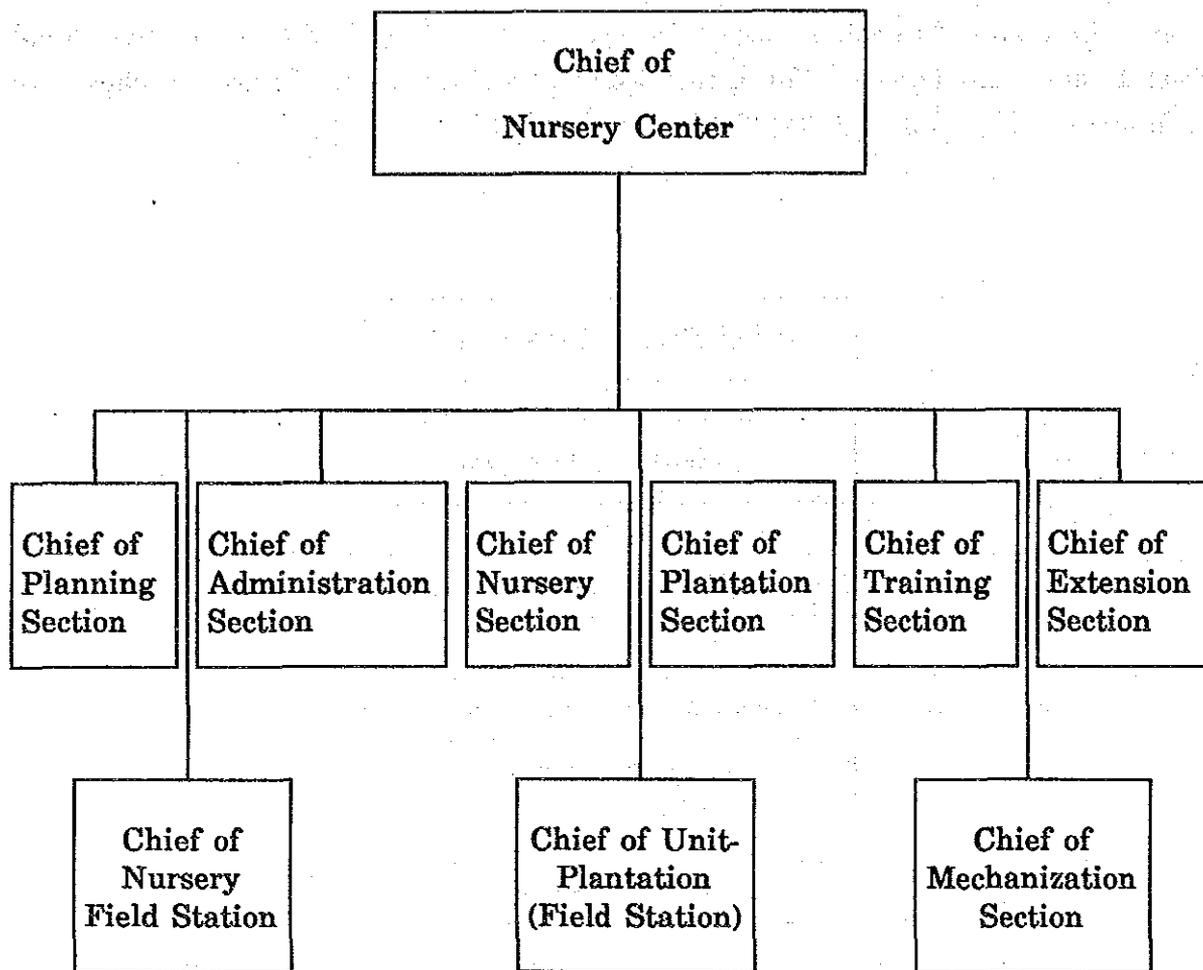


Fig. 3-3-2 Organization Chart of Each Nursery Center

Table 3-3-1 Official Staff of the Project I

Official Staff	Number
1. Forest Officer	69
2. General Administration Officer	13
3. Typist	8
4. Financier and Accountant Officer	4
5. Janitor	20
6. Electrician	4
7. Radio-Telephone Officer	4
8. Watchman	50
9. House-maid	1
10. Carpenter	4
11. Technical Agricultural Official	48
12. Laboratory Staff	9
13. Chief of Labourer	32
14. Labourer	114
15. Agricultural Labourer	24
16. Audio-visual Officer	4
17. Mechanic	18
18. Surveyor	4
19. Driver	22
20. Driver (Heavy-machine)	54
21. Driver (Middle-machine)	20
22. Driver (Light-machine)	36
23. Artist	5
24. Photographer	1
Total	568

Table 3-3-2 Official Staff of the Project II

Official Staff of the Project	Position	Person / 1 Center
1) Director of the Project	Forest Officer Level 6-7	(1)**
2) Field Director of the Project	Forest Officer Level 5-6	(2)**
3) Planning Section	Forest Officer Level 5-6 Forest Officer Level 3-5 General Administration Officer (Certificate)	1 (Chief) 1 1
4) Administration Section	General Administration Officer (Bachelor Major English) General Administration Officer (Bachelor, Sociology) Typist (Certificate) Financier and Accountant Officer (Diploma) Janitor Electrician Radio-Telephone Officer (Certificate) Watchman House-maid Carpenter	1 (Chief) 1 2 1 4 (8)* 1 1 12 (14)* 1* 1
5) Nursery Section	Forest Officer Level 5-6 Forest Officer Level 3-5 Technical Agricultural Official (Certificate) Technical Agricultural Official (Diploma) Laboratory Staff (seed) Chief of Labourer Labourer	1 (Chief) 4 1 1 1 1 5 8

6) Reforestation Section	Forest Officer Level 5-6 Forest Officer Level 3-5 Technical Agricultural Official (Diploma) Agricultural Labourer Laboratory Staff (Soil, Pathology, Entomology) Chief of Labourer Labourer	1 (Chief) 3 3 6 1 (2)* 3 6
7) Extension Section	Forest Officer Level 5-6 Forest Officer Level 3-5 Technical Forest Official or Technical Agricultural Official (Bsc. Forest or Agricultural Sciences) Artist (Certificate) Audio-visual Officer (Certificate) Labourer	1 (Chief) 3 7 1 1 7
8) Mechanization Section	Forest Officer Level 5-6 Mechanic (Diploma) Mechanic (Certificate) Surveyor (Certificate) Driver Driver (Heavy-machine) Driver (Middle-machine) Driver (Light-machine) Labourer	1 (Chief) 1 3 (5)* 1 4 (10)* (54)** (20)** (36)** (30)**
9) Training Section	Forest Officer Level 4-6 Forest Officer Level 3-5 Artist (Certificate) Photographer (Diploma) Administration Officer (Training)	(1) (Chief) (1)** (1)** (1)** (1)**

Note : * Main Center Only, ** 4 Centers

3-3-2 Plan of Activities

The plan of activities related to the Integrated Reforestation and Extension Project in the Northeast of Thailand, which serves as the basis for the Project is broken down into the headings given below.

(1) Long Plan Reforestation in the Northeast of Thailand

According to the Long Plan of Reforestation Program in the Northeast of Thailand covering the 30 years between 1991 and 2020, a total of 2,335,744ha, including 518,400ha of the government agencies, 444,544ha of the communities and 1,372,800ha of the private sectors, are earmarked for reforestation in the northeastern region. The area reforested under the Integrated Reforestation and Extension Project in the Northeast of Thailand is included in the above total. The Details for the various regions and provinces are given in Table 3-3-3.

Table 3-3-3 Long Plan of Reforestation in the Northeast of Thailand
(1991 ~ 2020)

Unit : rai (1 ha. = 6.25 rai)

Province	Reforestation Area			
	Government	Community	Private	Total
<u>Nakhonratchasima</u>				
- Nakhon Ratchasima	1,000,000	300,900	640,000	1,940,900
- Buriram	100,000	222,200	700,000	1,022,200
- Chaiyaphum	100,000	110,500	300,000	510,500
Sub-total	1,200,000	633,600	1,640,000	3,473,600
<u>Udonthani</u>				
- Udonthani	190,000	231,500	770,000	1,191,500
- Loei	500,000	96,800	1,400,000	1,996,800
- Nongkhai	300,000	128,600	750,000	1,128,600
- Sakonnakhon	300,000	136,600	480,000	916,600
- Nakhon Phanum	-	90,800	200,000	340,800
- Mukdahan	-	50,600	50,000	100,600
Sub-total	1,290,000	734,900	3,650,000	5,674,900
<u>Khonkaen</u>				
- Khonkaen	150,000	194,400	650,000	994,400
- Mahasarakham	-	144,900	70,000	214,900
- Roiet	-	196,500	140,000	336,500
- Kalasin	100,000	137,000	350,000	587,000
Sub-total	250,000	672,800	1,210,000	2,132,800
<u>Ubon Ratchathani</u>				
- Ubonratchathani	100,000	278,500	900,000	1,278,500
- Surin	200,000	182,100	480,000	862,100
- Sisaket	100,000	199,000	550,000	849,000
- Yasothon	100,000	77,500	150,000	327,500
Sub-total	500,000	737,100	2,080,000	3,317,100
Total	(518,400 ha.) 3,240,000	(444,544 ha.) 2,778,400	(1,372,800 ha.) 8,580,000	(2,335,744 ha.) 14,598,400

(2) Five Year Plan of the Integrated Reforestation and Extension Project in the Northeast of Thailand

The five-year plan of the Integrated Reforestation and Extension Project in the Northeast of Thailand (1991 ~ 1995) embodies as its substance the activities undertaken at the four Nursery Centers to be established under the Project. The principal activities planned for the five-year period are given in Table 3-3-4.

Table 3-3-4 Five Year Plan of the Project

Items	Unit	Year					Total
		1991	1992	1993	1994	1995	
1. Seedling production	million seedling	4	9	29	29	29	100
2. Extension and seedling distribution	village	108	240	774	774	774	2,670
3. Demonstration plantation	rai	2,000	8,000	12,000	12,000	12,000	46,000
4. Tending	rai	-	2,000	10,000	22,000	34,000	68,000
5. Forest road construction	km.	-	48	72	72	72	264
6. Fire line construction	km.	-	20	100	220	340	680
7. Training	course	-	4	36	36	36	112

(3) Target Villages in the Northeast part of Thailand for Forest Extension and Seedling Distribution

The extension and Seedling Distribution among the villages in the northeast part of Thailand, where shortage of timber (principally fuel wood and charcoal) is prevalent, constitutes one of the important activities of the Integrated Reforestation and Extension Project in the Northeast of Thailand. The target villages of this service includes 1,285 in the area under the Nakhon Ratchasima Regional Forest Office, 1,958 in the area under the Udonthani Regional Forest Office, 949 in the area under the Khon Kaen Regional Forest Office and 1,790 in the area under the Ubon Ratchathani Regional Forest Office, totaling 5,982 villages. The breakdown thereof is shown in Table 3-3-5.

Table 3-3-5 The Target Villages in the Northeast Part of Thailand for Forest Extension and Seedling Distribution

Unit : Number of Villages

Regional Forest Office	Province	Wood-shortage villages*
Khon Kaen	Khon Kaen	448
	Kalasin	156
	Maharakham	173
	Roiet	172
	Sub-total	949
Ubon Ratchathani	Ubon Ratchathani	624
	Surin	458
	Sisaket	492
	Yasothon	215
	Sub-total	1,790
Udon Thani	Udon Thani	639
	Loei	359
	Nongkhai	327
	Sakon Nakhon	298
	Nakhon Phanom	128
	Mukdahan	207
	Sub-total	1,958
Nakhon Ratchasima	Nakhon Ratchasima	569
	Buriem	326
	Chaiyaphum	354
	Sub-total	1,285
Total		5,982

* Source :The National Rural Development Co-ordination Centre,
Thamasart University, Bangkok, Thailand

(4) Plan for Establishment of Demonstration Plantation

As for the demonstration plantation under direct management of the four Nursery Centers, a total of twelve sites with an area of 7,360 ha, including eight sites with the area of 4,840 ha for conservation basis and four sites with the area of 2,520 ha for economic basis, are to be established in the five year period between 1991 and 1995. The five year plan of the establishment of demonstration plantation is shown in Table 3-3-6.

Table 3-3-6 Establishment of Demonstration Plantation (1991 ~ 1995)

Unit : rai (ha)

Items	Center	Year					Total
		1991	1992	1993	1994	1995	
1. Demonstration Plantation for Conservation Basis	Mahasarakham	(80)	(320)	(480)	(480)	(480)	(1,840)
		500	2,000	3,000	3,000	3,000	11,500
	Udonthani	-	(320)	(480)	(480)	(480)	(1,760)
			2,000	3,000	3,000	3,000	11,000
	Nakhonratchasima	(120)	(160)	(320)	(320)	(320)	(1,240)
	750	1,000	2,000	2,000	2,000	7,750	
	Sub-total	(200)	(800)	(1,280)	(1,280)	(1,280)	(4,840)
		1,250	5,000	8,000	8,000	8,000	30,250
2. Demonstration Plantation for Economic Basis	Nakhonratchasima	(120)	(160)	(160)	(160)	(160)	(760)
		750	1,000	1,000	1,000	1,000	4,750
	Yasothon	-	(320)	(480)	(480)	(480)	(1,760)
			2,000	3,000	3,000	3,000	11,000
	Sub-total	(120)	(480)	(640)	(640)	(640)	(2,520)
		750	3,000	4,000	4,000	4,000	15,750
Total		(320)	(1,280)	(1,920)	(1,920)	(1,920)	(7,360)
		2,000	8,000	12,000	12,000	12,000	46,000

The location of the proposed sites for demonstration plantation is shown in Table 3-3-7 and in Fig. 3-3-3.

Table 3-3-7 Location of the Proposed Sites for Demonstration Plantation

Location	Province	Start Year
Maharakham N.C. - Dong Mae Phet - Dong Lan - Sum Khan	Kalasin Khon Kaen Khon Kaen	1991 1992 1993
Nakhonratchasima N.C. - Sakaerat - Tablan - Phukii	Nakhon Ratchasima Nakhon Ratchasima Chaiyaphum	1991 1991 1993
Udonthani N.C. - Tompakha - Wung Sang Mor - Phu Kao Phupankham	Udonthani Udonthani Udonthani	1992 1992 1993
Yasothon N.C. - Huay Sala - Bun Tharik - Phon Ngam-Dong Por	Srisaket Ubonratchathani Yasothon	1992 1992 1992

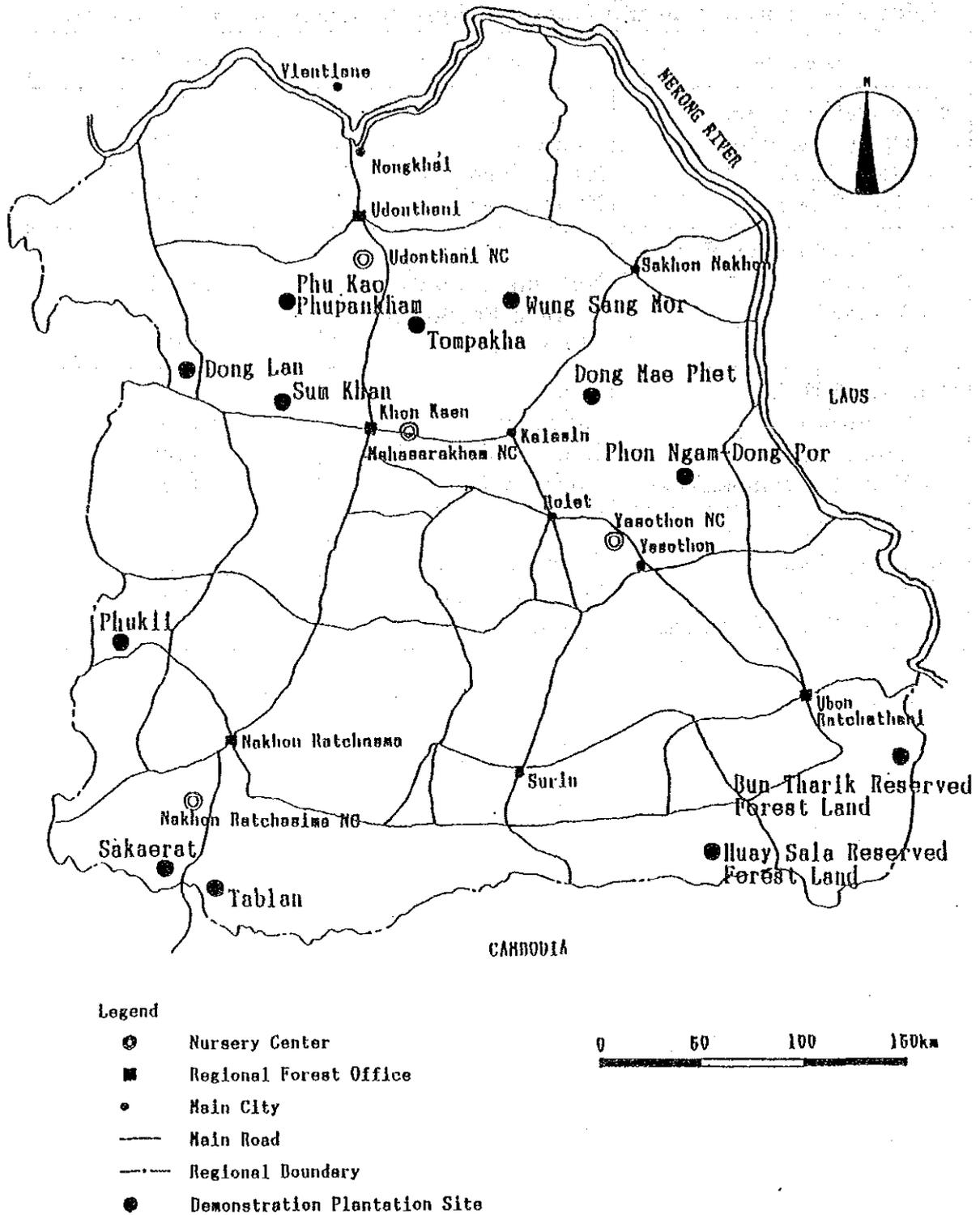


Fig. 3-3-3 Location Map of the Proposed Sites for Demonstration Plantation

(5) Training Plan

The training sessions scheduled to be provided in the 4-year period between 1992 and 1995 at the four nursery centers total 112 courses (for details refer to Table 3-3-8).

Under this study and training plan, training for the government-related staffers, which constitutes the nucleus of the Integrated Reforestation and Extension Project in the Northeast of Thailand, is to be provided at the Mahasarakham Nursery Center, the central basis of the four Nursery Centers. This is aimed to spread the effect far and wide, at the other three Nursery Centers located respectively in Nakhon Ratchasima, Udonthani and Yasothon but attention is to be focused on the grass-roots reforestation activities the village leaders and general farm inhabitant's.

According to this plan, moreover, no training sessions for the village leaders and general farmers at the Mahasarakham Nursery Center are planned. Therefore, the village leaders and farmers living in Khon Kaen regional area, which lies in the heart of the northeastern region of Thailand, are free to attend the training sessions given at the other three nursery centers.

Table 3-3-8 Training Program (1992 ~ 1995)

Unit : Course

Items	1992	1993	1994	1995	Total
	M N Y U	M N Y U	M N Y U	M N Y U	
1. Nursery and Plantation Practices					
- Government Sector (including Teacher)	1 - - -	5 - - -	4 - - -	3 - - -	13
- Private (Village Leader)	- - - -	- 2 2 2	- 2 2 2	- 1 2 1	16
- Local People	- - - 1	- 2 3 2	- 3 2 3	- 1 2 2	21
Sub-total	1 - - 1	5 4 5 4	4 5 4 5	3 2 4 3	50
2. Agroforestry Practices					
- Government Sector (including Teacher)	- - - -	4 - - -	5 - - -	3 - - -	12
- Private (Village Leader)	- - - -	- 2 2 2	- 2 2 2	- 1 1 2	16
- Local People	- 1 1 -	- 3 2 3	- 2 3 2	- 2 1 2	22
Sub-total	- 1 1 -	4 5 4 5	5 4 5 4	3 3 2 4	50
3. Wood Utilization					
- Government Sector (including Teacher)	- - - -	- - - -	- - - -	3 - - -	3
- Private (Village Leader)	- - - -	- - - -	- - - -	- 2 1 1	4
- Local People	- - - -	- - - -	- - - -	- 2 2 1	5
Sub-total	- - - -	- - - -	- - - -	3 4 3 2	12
Total	1 1 1 1	9 9 9 9	9 9 9 9	9 9 9 9	112

Note : 1. 50 persons/course

2. M : Maharakham N.C. N: Nakhon Ratchasima N.C.

Y : Yasothon N.C.

U: Udonthani N.C.

3-3-3 Location and Condition of Project Site

(1) Mahasarakham

The Project site is located approximately 14km east of Khon Kaen city along the national highway No. 209. The elevation is about 160m above sea level. The total area is roughly estimated to be 33ha extending eastwest with gentle slopes.

The site is close to a large reservoir at its west end where there is a shallow well constructed for the purpose of supplying irrigation water to the existing nursery of about 0.5ha. The water is pumped up twice a day from the shallow well, two hours in the morning and evening, to cover about 24m³ of daily water requirement.

Potable water is currently supplied to the family of the nursery caretaker by conduction pipes coming from Ban Kutong village located at the opposite side of the highway.

A electric power is also available to the project site with two overhead lines, and it is supplied to the existing nursery facilities after being reduced from 22KV to 220V. It can be said that the power failure occurs less frequently as the fluctuation in voltage.

The telephone system is provided in a small village which is about 4km east of the Project site. It is therefore required for the Project to extend the system to the site under the obligation of the Thai Government.

(2) Nakhon Ratchasima

The Project site lies about 7km southwest of Khorat. It slopes down at about 4% from east to west with an elevation of 220 ~ 230m above sea level. As sandy loam is predominant in the site, it is made up of well drainable soil. The total area, approximately 41ha, is owned by the Royal Forest Department (RFD). There is an artificial reservoir (catchment area: 10.7Km²) at the northern end of the area which is designed to have a maximum capacity of 1.65×10⁶m³ and minimum of 0.12×10⁶m³. Presently, a deep well is fully used to supply irrigation water for the nursery. However, it takes one hour and forty five minutes to fill the elevated tank (9m³) since pump capacity is as small as 1.5HP.

The electric power is supplied with single phase 220V for the energy source of submergible pump as well as existing temporary office.

One telephone line is actually provided for the forest fire control center located closely to the northwest area of the site.

(3) Udonthani

The location of the Project site is about 7Km south of the city of Udonthani and 2km away from the national highway No. 2. The northern boundary is lined with a gravel village road. The total area is estimated to be 29ha extending north-south. The site is relatively flat with an elevation of 180m above sea level. Since soils are constituted of sandy loam with 6.5 PH, it has low fertility.

There are three reservoirs in the Project site, each of which may be judged unsuitable for the Project's water resource because the water level is considered to be very low in mid-dry season. The south zone of the site seems to be swampy and undrainable. Irrigation water is currently supplied from both the reservoir and well for 0.5ha of nursery.

The electric power line of the single phase 22KV is installed along the provincial road branching off from the highway. However, no power system is installed along the village road which forms a link between the provincial road and the Project site. No telephone system is available in and around the Project site.

(4) Yasothon

The Project site is situated nearly 11Km northwest of the city of Yasothon. The elevation of the site is 137m above sea level. The proposed land is about 29ha, and it is flat with no undulations. The east boundary is close to the highway No. 23. Judging from the fact that there is no surface water in and around the project site, ground water seems to be the only available water resource. At present, irrigation water for the existing nursery is supplied from two deep wells. One provided with 5HP engine pump supplies the water daily for two hours daily from 9 to 11, and the other one with 1HP motor pump is for three hours until the tank is filled up with water.

The electric power along the highway is 3 phase 22KV through overhead line. However, no power system is installed so far to the Project site except for the single phase 220V provided from the neighboring land for the operation of 1HP pump.

In view of the fact that the only available water resource in Yasothon is the groundwater, geo-physical survey is required in order to analyze the potentiality of ground water development.

Upon the request of the mission through RFD, resistivity survey was carried out on February 7, 1991 by a technical team of the Khon Kaen University, and the results are summarized as follows;

Table 3-3-8 Data of Electricity Resistance Survey

Point	No. of levels	Value of Electricity Resistance, Ohm, Metres / Thickness, Metres					
		1st level	2nd level	3rd level	4th level	5th level	6th level
1/YASO 1	4	12175/1.5	496/8.1	71/5.3	214/-	-	-
2/YASO 2	5	27205/1.4	736/6.6	9/10.2	151/24	23/-	-
3/YASO 3	4	6879/2.8	687/2.6	177/91.5	360/-	-	-
4/YASO 4	5	6238/1.2	706/4.9	687/3.1	450/19.8	65/-	-
5/YASO 5	6	4297/2.9	108/2.5	3453/7.7	144/43	178/12.7	303/-

Based on the data analysis the form of the specific electricity resistance of the level of soil, rock and thickness at the particular survey points are shown in Fig. 3-3-4.

From the information in Table 3-3-8, at the depth of 15 meters artesian water can be found, but if not deep enough, water will not be sufficient. At this depth water can be recharged from Chee river. In this case, if the well is deeper than 15 meters, it will have more water but should not be deeper than 45 meters as the water will be salty according to the limited geology of the area. There are 6 artesian wells digged during 1977 ~ 1988 within 5Km of the project site.

It should be noted that one produces 385 gallons/minute and the other one is 69 gallons/minute. The wells at Wat Ban Ram Bon and Wat Pa Sri Sunthorn are supposed to have very high potentials producing 100 and 190 gallons per minute respectively at the depth of 33 meters. Both places are only 2Km away from the proposed site.

From the study of the data of the nearby artesian wells and the data of electricity resistance survey at the 5 points, it can be concluded that this area has very high potentiality for groundwater development. However, it is desirable to make a boring test and a pumping test before the Project implementation in order to ensure the quantity of available groundwater.

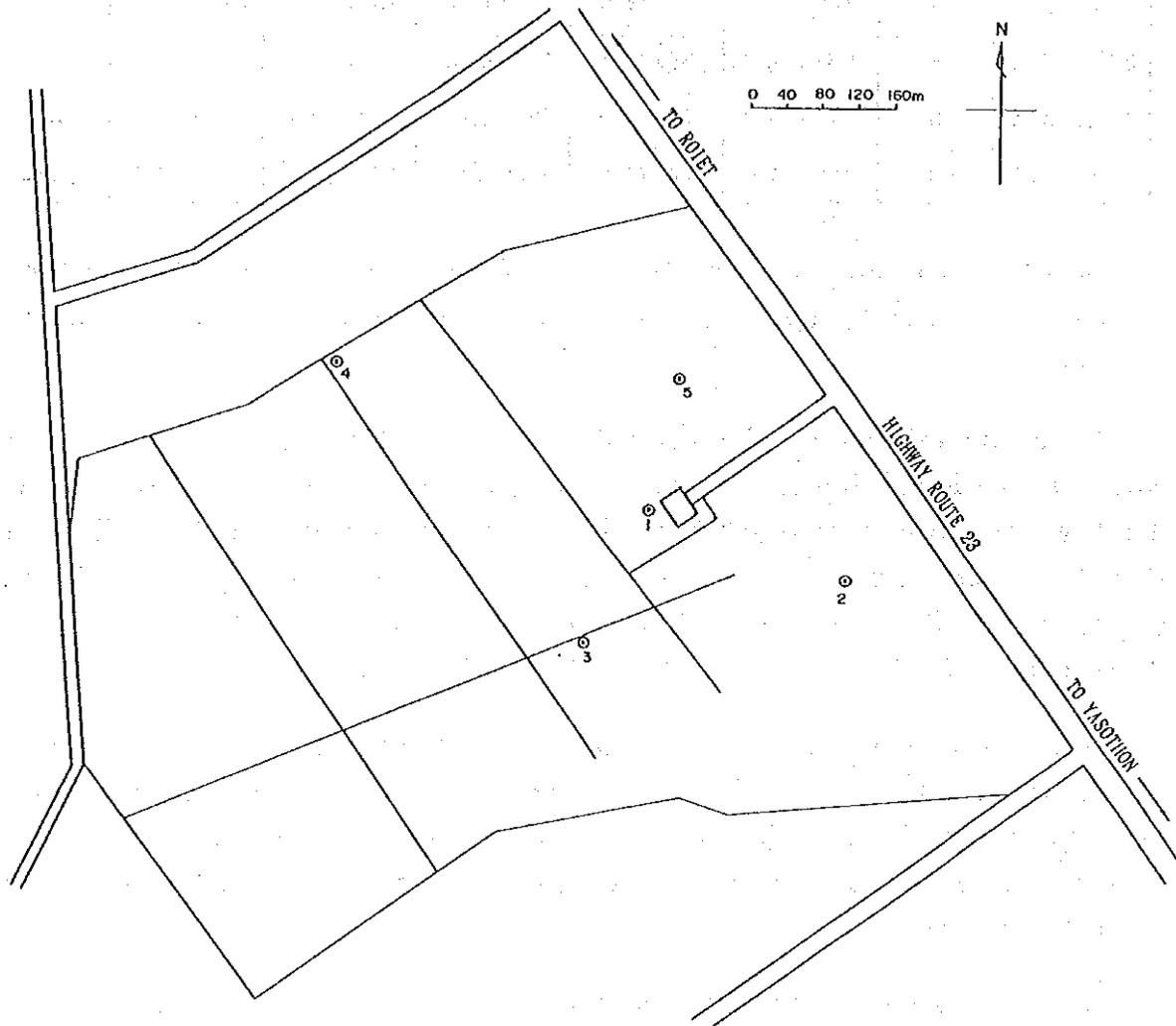


Fig. 3-3-4 Selected Points for Geo-physical Survey of the Proposed Project Site Yasothon

3-3-4 Outline of Facilities and Equipment

(1) Facilities

The facilities of the Project are classified into administration, nursery and nursery related facilities. The outline of the facilities are described as follows;

1) Administrative Facility

◦ Main Office and Training Building

The main building of each Nursery Center consists of an administration section room, a chief of center room, lecture room, experts and JOCV room, laboratory and seed cold storage room. As the main center of the Project, Mahasarakham Nursery Center shall contain the Project and field directors room, leader of experts room, library room and cafeteria.

The office and training building for Mahasarakham Nursery Center is planned to be a two-storied building and those for Nakhon Ratchasima, Udonthani and Yasothon are planned to be one-story buildings.

◦ Workshop

In order to maintain and repair vehicles and heavy machines, a workshop with an office room and storage rooms for spare parts in its mezzanine floor is planned.

◦ Garage

Considering the types and number of vehicles, two garages for Mahasarakham Nursery Center and one for the other three Nursery Centers are proposed.

◦ Generator House

A generator house is constructed, one unit of generator and a power receiving board with a control panel board for emergency.

◦ Oil Tank Base

An oil tank base is located beside the garage in order to supply fuel and oil to the vehicles and machinery.

2) Nursery Facility

◦ Closed Nursery/Germination House

It will be used as facility for planting seeds in the seed bed and growing the seedlings before transplanting it to the pots.

◦ Vinyl House

A facility for producing rooted cuttings.

◦ Open Nursery

A facility for planting seedlings growing in the closed nursery/germination house into plastic pots containing mixed medium and growing potted seedlings.

◦ Potting House

A place for filling mixed soil in the plastic pots for growing seedlings under the conveyor system process.

◦ Compost House

A facility for producing compost to be used as a component material of the pot medium.

◦ Storage House

A place for storing plastic bags, fertilizer, insecticide, and other materials, in addition to tools, machines, etc. used in the nursery.

◦ Seed Solar Dryer

Through the use of solar rays, a facility is used for drying seeds of Leguminosae trees that are enclosed in pods with a view to making the seeds payable out of the pods. It is effective for reducing the moisture content of the seeds, improving their germination rate and reinforcing their storability.

This facility is included in the equipment and material group in the request, but it has been changed to a facility as it has to be set up with a concrete foundation.

3) Other Appurtenant Facility

◦ Pump Station

The required volume of water will be pumped up from the reservoir to the distribution tank through the pipe. However, a deep well should be established in the case of Yasothon since groundwater is the only available water resource.

◦ Water Distribution Tank

To minimize energy consumption by the distribution of water, topography should be taken into consideration in selecting the most favorable place.

◦ Water Tank

To be built in each nursery with an effective capacity of water required for one day.

◦ Work Road

To be built for tractors and other machineries. The road network is designed to enclose two units of open nursery.

◦ Access Road

To be provided as a main route to the office and training building from the gate of the nursery center.

◦ Drainage Facility

To facilitate the natural drainage system by collecting rain water through ditches provided on both sides of the road.

Among the above-mentioned facilities, the area of each main facility is tabulated in Table 3-3-9.

Table 3-3-9 Area of Building

	Maharakham	Nakhon Ratchasima	Udonthani	Yasoton	Total
Main Office and Training Building	(1) 1,220.5	(1) 702.5	(1) 702.5	(1) 702.5	(4) 3,328.0
Workshop	(1) 200.0	(1) 200.0	(1) 200.0	(1) 200.0	(4) 800.0
Garage A	(1) 250.0				(1) 250.0
Garage B	(1) 288.0	(1) 288.0	(1) 288.0	(1) 288.0	(4) 1,152.0
Storage House	(1) 150.0	(1) 150.0	(1) 150.0	(1) 150.0	(4) 600.0
Generator House	(1) 50.0	(1) 50.0	(1) 50.0	(1) 50.0	(4) 200.0
Closed Nursery (Germination House)	(2) 1,600.0	(2) 1,600.0	(2) 1,600.0	(2) 1,600.0	(8) 6,400.0
Vinyl House	(2) 150.0				(2) 150.0
Open Nursery	(50) 40,000.0	(50) 40,000.0	(50) 40,000.0	(50) 40,000.0	(200) 160,000.0
Potting House	(1) 480.0	(1) 480.0	(1) 480.0	(1) 480.0	(4) 1,920.0
Compost House	(1) 80.0	(1) 80.0	(1) 80.0	(1) 80.0	(4) 320.0

Note; 1. () means the number of building or blocks in case of open nursery.

2. Main office and training building of Maharakham Nursery Center includes the area of cafeteria 171.0m².

(2) Equipment

1) Equipment and Tools

◦ For Nursery

For the seed collection and nursery activities, equipment and tools for the nursery contain seedling containers, potting stands (only for Mahasarakham Nursery Center), knock-down nursery, u-shape shed nets, etc..

◦ For Plantation

For forest fire control and surveying, plantation equipment and tools include back-pack pumps, VHF/FM transceiver set, etc..

◦ For Administration and Extension

For the administrative work and the preparation of the training tools, equipment and tools for administration and extension contain automatic copying machines, facsimile machines, etc..

For the extension purpose, those include single side band transceiver, personal microcomputer sets, etc..

In addition to these, cameras with accessories and others are included except for Mahasarakham Nursery Center.

◦ For Workshop

In order to realize preventive maintenance and repair of the vehicles and heavy machinery, car washers, parts washing stands, garage jacks, fuel and oil stations and others are provided.

◦ For laboratory

- Nursery Laboratory

For the laboratory test for nursery production, a thermostic germinator (only for Mahasarakham Nursery Center), seed dividers and others are provided.

- Plantation Laboratory

For soil test for the selection of suitable plants, field pH meter, balance set (only for Mahasarakham Nursery Center), oven (only for Mahasarakham Nursery Center), furnace (only for Mahasarakham Nursery Center), etc..

- Pathology Laboratory

The equipment and tools for the pathology laboratory are only supplied to Mahasarakham Nursery Center and contain a clean bench, incubators, an autoclave, a compounding microscope, a microtome knife sharpener, etc..

- Extension and Training Laboratory

For the preparation of training materials such as slides and video films and for efficient extension and training, the necessary equipment and tools include a camera with accessory, a slide projector audio - system for lecture room etc.

- Glass Ware

Glass ware is required for the test of seedling production and soil analysis, and since Mahasarakham Nursery Center is the main center, it requires much more glass ware than the others.

2) Machinery

o Heavy Machine

Wheel loader and trucks for transportation (with crane & without crane) are provided mainly for the use of nursery activities. Bulldozers (large), hydraulic excavators, dump trucks, water tank trucks and farm tractors are supplied mainly for the demonstration plantation purposes.

o Vehicle

Pick-up trucks (small & 4WD) and motor cycles are provided for the extension work, field activities, fire control and others. For training in Mahasarakham Nursery Center, a station wagon and two minibuses are supplied.

o Other Machine

For the use of nursery activities, seed scarifying machine, coconut husk crusher, soil sieving machine, soil mixture machine and others are provided. For demonstration plantation activities, water pump, brush cutter and others are supplied.

3-3-5 Operation and Maintenance Plan

The expenses of the operation and maintenance for the facilities provided by the Project are classified into personnel expenses and facility operation expenses.

The results of the calculations of expenses are shown as follows.

Table 3-3-10 Calculation of expenses (Year)

Unit: 1000 Bahts

Classification		Maharakham	Nakhon Ratchasima	Udonthani	Yasothon	Total
Personnel Expenses		5,520	4,812	4,812	4,812	19,956
Facilities Operation Expenses	Electric Charges	333	235	226	253	1,047
	Telephone Charges	36	31	41	41	149
	Fuel and lubricants	2,336	1,993	1,993	1,993	8,315
	Vehicle maintenance	579	524	524	524	2,151
	Sub - Total	3,284	2,783	2,784	2,811	11,667
Total		8,804	7,595	7,596	7,623	31,618

Breakdown of calculation are as follows;

1) Personnel expenses

Classification	Per Year / person (Bahts) A	No. of staff		Total / Year (Bahts)			
		Mahasarakham B	Other C	Mahasarakham D=A×B	Other E=A×C	3 Centers F=E×3	Total D+F
(Office Staff)							
Project Director	144,000	1	-	144,000	-		
Field Director	120,000	2	-	240,000	-		
Chief of Center	120,000	1	1	120,000	120,000		
Section Chief	96,000	7	7	672,000	672,000		
Staff (Senior)	84,000	19	19	1,596,000	1,596,000		
Staff (Middle)	48,000	15	15	720,000	720,000		
Staff (Junior)	36,000	14	12	504,000	432,000		
Typist	36,000	2	2	72,000	72,000		
Sub-total		61	55	4,068,000	3,612,000	10,836,000	14,904,000
(Other Staff)							
Watchman etc.	36,000	14	10	504,000	360,000		
Driver (A)	48,000	4	4	192,000	192,000		
Driver (B)	36,000	4	3	144,000	108,000		
Driver (C)	36,000	17	15	612,000	540,000		
Sub-total		39	32	1,452,000	1,200,000	3,600,000	5,052,000
Total		100	87	5,520,000	4,812,000	14,436,000	<u>19,956,000</u>

2) Facility operation expenses

o Electric charges

- Calculation of power consumption

Facility	Installed load (KW)	Running hour (H/Day)	Running day (Day/M)	Demand factor (%)	Power consumption (KWH/M)
(Mahasarakham)					
Main building	54	9	25	50	6,075
Workshop	31	5	25	30	1,163
Pump	23	4	30	65	1,794
Equipment	99	8	25	20	3,960
Others	21	12	30	30	2,268
Total					15,260
(Nakhon Ratchasima)					
Main building	31	9	25	50	3,488
Workshop	31	5	25	30	1,163
Pump	21	4	30	75	1,890
Equipment	49	8	25	20	1,960
Others	21	12	30	30	2,268
Total					10,761
(Idonthani Honthani)					
Main building	31	9	25	50	3,488
Workshop	31	5	25	30	1,163
Pump	16	4	30	75	1,440
Equipment	49	8	25	20	1,960
Others	21	12	30	30	2,268
Total					10,319
(Yasothon)					
Main building	31	9	25	50	3,488
Workshop	31	5	25	30	1,163
Pump	20	9	30	50	2,700
Equipment	49	8	25	20	1,960
Others	21	12	30	30	2,268
Total					11,579

Electric charges applicable to this Center are calculated as follows,
 up to 10 KWH : 18.2 Bahts (minimum charge)
 over 10 KWH : $1.82 \times$ power consumption (KWH)

- Monthly and annual electric charges

Center	Monthly charges	Annual charges
Maharakham	$18.2 + (15,250 \times 1.82) = 27,773$ Bahts	333,276 Bahts
Nakhon Ratchasima	$18.2 + (10,751 \times 1.82) = 19,585$	235,020
Udonthani	$18.2 + (10,309 \times 1.82) = 18,780$	225,360
Yasothon	$18.2 + (11,569 \times 1.82) = 21,073$	252,876
Total	87,211	<u>1,046,532</u>

o Telephone charges

Telephone rate : up to 3 minutes 1 Baht (local call)

1 minute 12 Bahts (Bangkok-Nakhon Ratchasima)

1 minute 15Bahts (Bangkok-Maharakham)

1 minute 18Bahts (Bangkok-Udonthani, Yasothon)

Number of calls : 30 calls/day for local and 6 calls/day for long distance

Time per call : less than 3 minutes

Classification	Month	Year
Maharakham	$\{(30 \times 1) + (6 \times 15)\} \times 25 \text{ days/month} = 3,000$ Bahts	36,000 Bahts
Nakhon Ratchasima	$\{(30 \times 1) + (6 \times 12)\} \times 25 \text{ days/month} = 2,550$	30,600
Udonthani	$\{(30 \times 1) + (6 \times 18)\} \times 25 \text{ days/month} = 3,450$	41,400
Yasothon	$\{(30 \times 1) + (6 \times 18)\} \times 25 \text{ days/month} = 3,450$	41,400
Total	12,450	<u>149,400</u>

◦ Fuel and lubricant costs

Classification	Year
Maharakham	2,336,000 Bahts
Nakhon Ratchasima	1,993,000
Udonthani	1,993,000
Yasothon	1,993,000
Total	<u>8,315,000</u>

◦ Vehicle maintenance cost

Classification	Year
Maharakham	579,000 Bahts
Nakhon Ratchasima	524,000
Udonthani	524,000
Yasothon	524,000
Total	<u>2,151,000</u>

3-4 Technical Cooperation

According to the minutes of the meeting of the preliminary survey on the Integrated Reforestation and Extension Project in the Northeast of Thailand, the outline of the Technical Cooperation including Japan Overseas Cooperation Volunteers (JOCV) are as follows;

1) Technical Cooperation

◦ Experts

- Leader

- Expert (Reforestation) ; main emphasis on private reforestation

- Expert (Training) ; main emphasis on private reforestation but including teachers

- Expert (Extension) ; private only, particularly "grass-roots' level"

- Expert (Nursery)

- Expert (Coordinator)

◦ Provision of Equipment

Items necessary for the operation of the Project other than those provided under the Grant Aid Scheme.

◦ Training in Japan

Training designed for selected counterpart staff in the respective fields.

◦ Special Measures

Possible contribution to reforestation and training.

2) Japan Overseas Cooperation Volunteers (JOCV)

Four volunteers, one for each Nursery Center, will be assigned to work mainly for the establishment of model community forests including base-line surveys of the selected communities, technical guidance and monitoring of their activities.

CHAPTER 4
BASIC DESIGN

CHAPTER 4 BASIC DESIGN

4-1 Design Policy

(1) Overall Policy

For the execution of the basic design, the overall policy is described as follows:

- 1) The basic design will be made with sufficient consideration on the local climate, natural features, local customs and other characteristics.
- 2) In order to reduce energy consumption, utilization of natural ventilation and lighting shall be considered in the design as much as possible. For the selection of construction materials, durable materials which can be procured in Thailand shall be applied as much as possible so that maintenance of the facilities shall be easy and the O&M cost shall be reduced due to the reduction of repairing frequency.
- 3) To achieve a reasonable and economical design, due consideration should be given to utilization of local construction techniques, materials, labour situation, etc..
- 4) The design shall basically conform to the relevant laws and regulations now in force in Thailand; however, the regulations and standards in Japan will be referred if relevant ones are not established in Thailand.
- 5) All four nursery centers of the Project will need administration facilities such as a main office and training building and nursery facilities for seedling production and others in their large proposed sites. Therefore, the layout of these facilities shall be designed in order to achieve an efficient work and sufficient seedling production.
- 6) As for the preparation of the equipment plan, the equipment which is compatible with the local conditions shall be selected as much as possible.

(2) Individual Policy

Individual policy is itemized as follows.

1) Natural condition

- Meteorology

Nearly 90% of the total annual precipitation in each project area is concentrated in the rainy season from May to October. Intensive rain fall frequently occurs between July and September. Monthly mean temperatures are almost constant throughout the year showing 26~27°C. However, daytime temperature is over 30°C and it rises to 35~36°C in April and May. The humidity is also very high in the rainy season indicating over 90%.

The meteorological information stated above should be taken into consideration in designing facilities.

The meteorological data in this region are shown in Table 4-1-1.

- Soil foundation

The main constituent of soils in each proposed area is sandy loam with good drainability. According to the existing data of boring conducted in the neighboring area of the project site, it requires a depth of 4~6m of soil to attain very stiff and hard clay. Judging from this fact the boring test shall be carried out on the detail design stage at the proposed location of the main office building.

2) Social condition

Each project site is situated in the suburbs of the provincial capital city and owned by the Royal Forest Department. There seems to be no problem about land ownership, but cadastral survey as well as topographic survey are required to be carried out for the detail design study. Since the site is located close to the public road and water resources, electric power can be provided easily for the project operation from the existing transmission line. The reservoirs are currently controlled by the local administration office, and no problem exists about water rights because the water is for public use.

Table 4-1-1 Meteorological Data (1956 ~ 1985)

(1) Monthly Mean Precipitation

unit : mm

Site	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Year
Maharakham	4.6	13.2	31.1	60.7	167.7	176.9	163.4	192.7	262.0	87.2	13.9	3.3	1,176.7
Nakhon Ratchasima	4.8	22.7	43.9	68.3	145.2	111.6	132.6	130.4	261.5	154.1	30.0	3.6	1,108.7
Udonthani	6.8	19.7	38.8	80.2	207.7	224.4	223.1	281.9	265.1	77.1	7.6	2.7	1,435.1
Yasothon	0.6	12.6	40.9	85.6	213.6	261.9	274.6	322.6	294.3	100.5	22.4	1.8	1,631.4

(2) Temperature

unit : mm

Site		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Year
Maharakham	Mean	22.8	25.6	28.7	30.1	29.2	28.6	28.0	27.6	27.0	26.5	24.8	22.8	26.8
	Max.	30.3	32.7	35.5	36.5	34.8	33.3	32.6	32.0	31.5	31.3	30.8	29.9	32.6
	Min.	15.7	19.1	22.2	24.4	24.7	24.7	24.2	24.1	23.6	22.3	19.3	16.3	21.7
Nakhon Ratchasima	Mean	23.0	25.9	28.3	29.2	28.5	28.2	27.7	27.4	26.7	26.0	24.4	22.7	26.5
	Max.	30.7	33.5	36.0	36.5	35.1	34.1	33.4	33.0	31.9	30.8	29.7	29.5	32.9
	Min.	16.3	19.7	22.2	23.8	24.2	24.1	23.7	23.6	23.2	22.4	19.9	16.9	21.7
Udonthani	Mean	21.8	24.5	27.6	29.3	28.5	28.2	27.8	27.4	27.1	26.5	24.5	22.0	26.3
	Max.	29.3	31.6	34.5	35.7	34.1	32.8	32.3	31.5	31.2	31.2	30.5	28.9	32.0
	Min.	15.3	18.3	21.6	24.0	24.6	24.9	24.6	24.4	24.0	22.7	19.5	16.0	21.7
Yasothon	Mean	23.5	25.9	28.9	29.6	28.8	28.1	27.6	27.2	27.0	26.5	25.0	23.4	26.8
	Max.	30.9	33.3	35.4	35.9	34.4	32.7	32.0	31.4	31.2	31.3	30.7	30.1	32.4
	Min.	16.8	19.4	22.4	24.3	24.6	24.4	24.1	23.9	23.7	22.4	20.0	17.6	22.0

(3) Monthly Mean Evaporation

unit : mm

Site	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Year
Maharakham	154.2	161.4	211.7	216.6	196.5	171.4	165.5	150.0	137.0	152.3	151.0	152.4	2,020.0
Nakhon Ratchasima	140.6	149.7	190.8	192.1	176.1	170.9	168.1	158.2	131.3	133.7	130.0	137.7	1,879.2
Udonthani	134.2	143.6	188.6	193.8	164.4	153.6	139.0	125.2	119.7	126.0	128.6	112.8	1,729.5
Yasothon	174.9	174.3	216.1	210.8	184.0	161.9	163.9	151.7	129.1	164.1	173.1	173.0	2,076.9

Note: Maharakham and Yasothon are based on the data collected from 1962 to 1985, Nakhon Ratchasima is based on 1961 to 1985 and Udonthani from 1976 to 1985.

Data collected in Khon Kaen and Ubon Ratchathani are used for Maharakham and Yasothon respectively.

Source: Meteorological Department, Ministry of Communications

3) Construction condition

It has been a few years since the construction rush started in Thailand. It is therefore very important to study the real situation of the construction business since the construction prices have jumped up due to the lack of basic materials such as iron bars and cement. Anticipating a long period of waiting for the procurement of materials, special care must be taken for the order time and supply method of materials and equipment. Since laborers are moving up to the capital from the northeast to look for employment opportunities, skilled workers are not easily available except in Bangkok. However, a number of general workers are locally available particularly in the dry season when farmers become unemployed.

4) Operation and maintenance

In designing facilities and equipment great care should be taken to ease operation and maintenance.

5) Implementation schedule

The project sites are dispersed in four different provinces in the northeast of Thailand, and the project itself includes many work items. All these facts shall be taken into consideration in establishing the implementation schedule. In addition, equipment supply plan, supervisory plan and the possibility to split the work in phases are also required to be carefully examined in determining overall work schedule.

4-2 Study and Examination on Design Criteria

(1) Administrative Facility

1) Design Principles

The total area of the buildings and the scale of each room are determined based on the following principles;

- Upon consideration of the Sakaerat Field Station and other similar facilities both in Thailand and abroad, the total floor area of each building is determined.
- In addition to the above - mentioned similar facilities, the scale of each room is designed based on the following data.
 - building design data book
 - attached documents of the request letter presented by the RFD
 - other related data
- The floor area of the rooms, such as laboratories which can not be determined by the number of personnel to be accommodated is decided in accordance with the equipment and tools to be installed in addition to the above - mentioned criteria.
- The floor area of the rooms, such as administration section room, meeting room, lecture room, etc., that can be determined by the number of personnel to be accommodated is designed based on the following standard figures. In addition to these, various conditions such as local work style, equipment and tools to be installed in the room, number of visitors, etc. shall also be considered.

- section office room	5.0~6.0m ² /person
- meeting and lecture rooms, etc.,	1.5m ² /person
- dining room	2.0m ² /person

2) Floor Area

◦ Office and Training Building for Mahasarakham Nursery Center

- Project director and Field director room	22.50m ²
- Chief of center room	20.00m ²
- Expert leader room	20.00m ²
- Experts and JOCV room	46.00m ²
- Administration section room(including reception)	51.00m ²
- Nursery and Planning section room	51.00m ²
- Extension, Reforestation and Training section room	127.50m ²
- Mechanization section room	20.00m ²
- Lecture room	102.00m ²
- Meeting room	49.50m ²
- Meeting and Seminar room	50.00m ²
- Laboratory	85.00m ²
- Library	34.00m ²
- Cold seed storage room	26.00m ²
- Preparation room	8.00m ²
- Dark room	5.00m ²
- Entrance hall	46.50m ²
- Dining room of Cafeteria	108.00m ²
- Kitchen room of Cafeteria	41.00m ²
- Laundry of Cafeteria	5.00m ²
- Kitchenette	3.50m ²

- Storage room	23.00m ²
- Toilet room	86.00m ²
- Others (corridor, staircase, etc.)	190.00m ²
Total Floor Area	<u>1,220.50m²</u>
◦ Office and Training Building for Nakhon Ratchasinma, Udonthani and Yasothon Nursery Centers.	
- Chief of center room	20.00m ²
- Administration section room(including reception)	50.00m ²
- Nursery and Planning section room	55.25m ²
- Extension, Reforestation and Training section room	127.50m ²
- JOCV room	12.50m ²
- Lecture room	97.75m ²
- Meeting and seminar room	42.50m ²
- Laboratory	67.50m ²
- Cold seed storage room	26.00m ²
- Entrance hall	17.00m ²
- Kitchenette	3.75m ²
- Storage room	17.05m ²
- Toilet room	50.50m ²
- Corridor	115.20m ²
Total Floor Area	<u>702.50m²</u>
◦ Workshop of Each Nursery Center	<u>200.00m²</u>

- First floor - workshop	125.00m ²
- Toilet	12.50m ²
- Storage	12.50m ²
- Mezzanine - staff room	25.00m ²
- Parts storage	20.00m ²
- Others (staircase, etc.)	5.00m ²
◦ Garage A only for Mahasarakham Nursery Center	<u>250.00m²</u>
Garage B for Each Center	<u>288.00m²</u>
◦ Generator House for Each Center	<u>50.00m²</u>
◦ Oil Tank Base (6m × 5m)	<u>30.00m²</u>

3) Building Facility

◦ Water Supply System

In Northeast Thailand, it is popular to utilize rain water as drinking water. In this Project, rain water is also to be used as an economical and stable water resource. Rain water will be stored in water tanks by collecting them from the eaves of the cafeteria and the office and training building. The low quality water such as for toilet and shower, will be pumped up from each water resource to each elevated tank. Then, water will be supplied to each room by gravity.

◦ Electrical System

The electric power supply work for the Project site will be conducted by Thai side. The electric power for the Project site is 22kv 50Hz 3 - phase 3 - wire system through the over head line. After the 22 kv power receiving point, the power supply system work for the Project will be included in the scope of the Japanese side work. A transformer will be installed on an electric pole, from which low voltage electric power (3 - phase 380V and single phase 220V) will be supplied to each load. As water supply for nurseries depends on electric power, a diesel engine generator will be installed at a generator house for emergency.

- Drainage System

Septic tanks will be constructed for the waste water from the toilet and treated water from the tanks will be penetrated into the soil at the penetration pit. Waste water from other places will be collected at the penetration pits which will be placed at lower points of the site. These waste waters will also be penetrated into the soil.

(2) Nursery Facility

Examination of the required nursery facility sizes requires the nursery practice working system and the nursery operation schedule as the pre-design conditions.

The nursery practice working system, which covers a series of work ranging from seed collection to the delivery of seedlings from the nursery, is the basis of any nursery operation and its relationship with the nursery facilities is illustrated in Fig. 4-2-1. The system illustrated in Fig. 4-2-1 was originally established under the Research and Training in Re-forestation Project and has been introduced nationwide by the RFD.

The nursery operation schedule which is currently employed by the four nursery centers is shown in Table 4-2-1.

Given the above 2 conditions, the required nursery facility sizes are examined below.

1) Closed Nursery (Germination House)

The number of the required nursery stocks to obtain 5 million seedlings at one nursery center is actually 5.863 million given the average yield of 85.3% for all tree species. The required nursery bed area to raise these nursery stocks was calculated to be 1,376.5m² using the number of seeds per kg, germination rate and sowing volume per m². While the calculation was based on the RFD data, the average nursery bed area was used for 3 species for which relevant data was not available.

The closed nursery will not be used for 3 species, i.e. *Pterocarpus macrocarpus* (290m²), *Dalbergia cochinchinensis* (59.4m²) and *Tectona grandis* (5.5m²), as they require open germination beds. As a result, the required area for the closed nursery is 1,022m².

The requested number of germination beds (closed nursery) is 50. As one bed is equivalent to 7.62m² (internal measurements : 0.86m × 8.86m = 7.62m²), the area of one unit (50 beds) is 381m². One nursery center has 2 units and, therefore, the area of the closed nursery is 762m² which is 260m² short of the required area of 1,022m². This shortage of the bed capacity can be overcome by sowing seeds of the following fast growing species in 2 or 3 operations with a resulting turnover rate of 1.35.

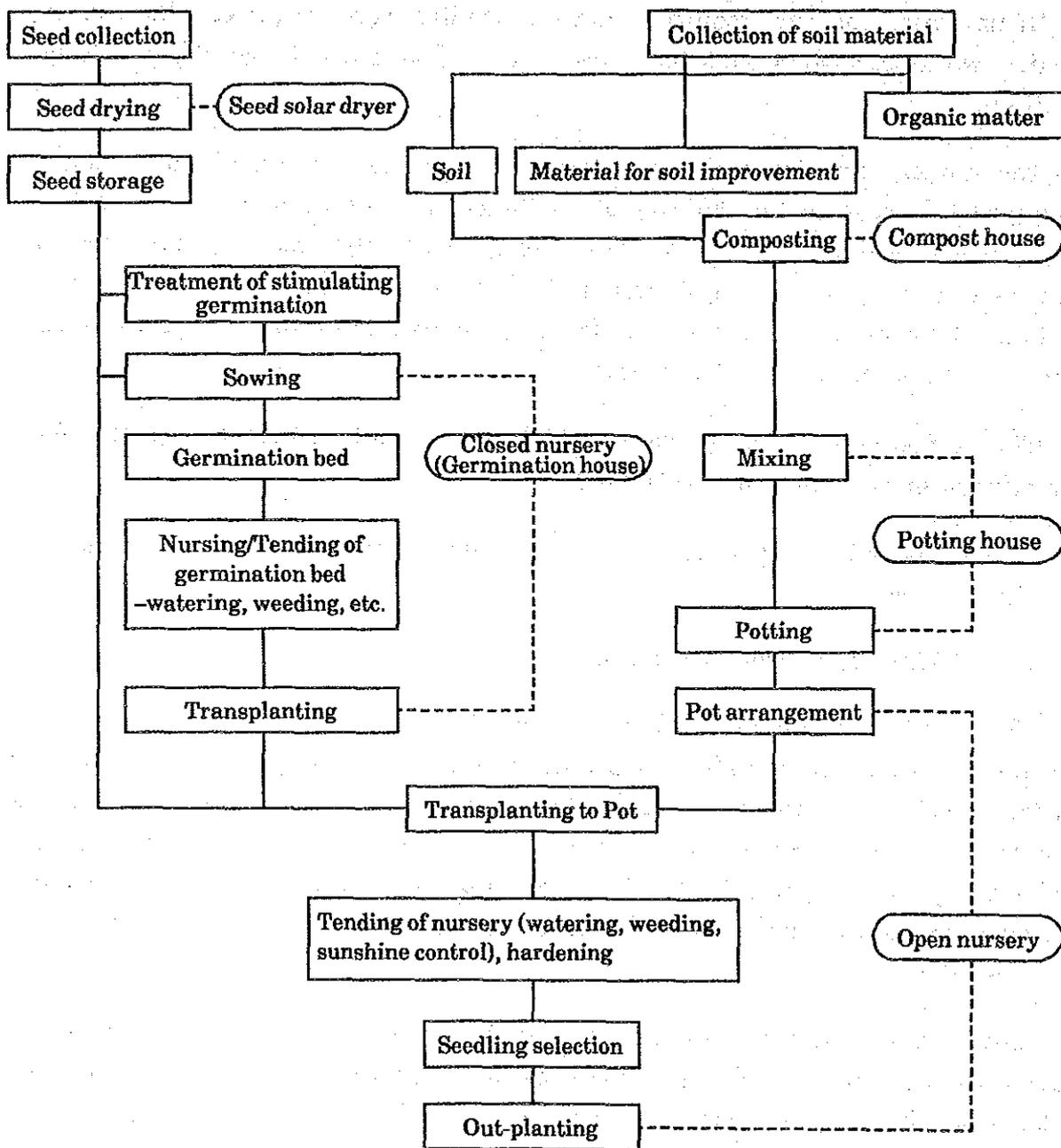


Fig. 4-2-1 Working System of Nursery Practice

Table 4-2-1 Nursery Operation Schedule

Items		Month	10	11	12	1	2	3	4	5	6	7	8	9
Nursery preparation	M													
	N													
	U													
Seedling demand survey	M													
	N													
	U													
Seed collection	M													
	N													
	U													
Medium preparation	M													
	N													
	U													
Fill containers	M													
	N													
	U													
Seed sowing Germination	M													
	N													
	U													
Transplanting / direct sowing	M													
	N													
	U													
Tending	M													
	N													
	U													
Outplanting	M													
	N													
	U													

Notes: M : Mahasarakham N : Nakhon Ratchasima
 U : Udonthani Y : Yasothon

<u>Species</u>	<u>Average germination Length</u>	<u>Germination Bed Area</u>
Eucalyptus sp.	5 days	43m ²
Hopea odorata	7 days	90m ²
Azadirachta indica	10 days	300m ²
Acacia sp.	11 days	86m ²
Cassia siamea	12 days	54m ²
	<u>Total</u>	<u>573m²</u>

The required germination bed area for these 5 fast growing species is 573m². If sowing is conducted in 2 separate operations, each operation will require 286.5m². The overall shortage of the bed space of 260m² can be compensated at the second sowing operation of these fast growing species.

2) Vinyl House

A vinyl house is a facility to nurse cuttings and its relationship with the nursery practice working system for nursing cuttings is shown in Fig. 4-2-2. The use of cuttings is a method to multiply species without losing the genetic characteristics of a superior individual and this method is used in Thailand by some private nurseries to grow *Eucalyptus camaldulensis*. While the method has not yet been adopted by the RFD nurseries, a practical method to use cuttings of *Eucalyptus camaldulensis* has been developed by the ASEAN-Canada Forest Tree Seed Center at Muak Lek in Saraburi.

Following the example set by the above Centre, the size of the vinyl house is set at 6m in width and 25m in length to maintain a house temperature between 25°C - 30°C using a ventilation fan.

The nursery area using Hiko blocks is 63m² (1m wide × 21m long × 3 rows) per unit. The number of Hiko blocks (each containing 36 mounded pots) per m² is 4 and the number of cuttings per unit is 9,072 (4 Hiko blocks/m² × 36 potted cuttings × 63m²). 18,144 cuttings can be nursed by one operation using 2 units. Since 2 operations are possible with Hiko blocks, the number of cuttings to be nursed is doubled to 36,288. The number of planting stocks based on a rooting rate of 70% is 25,400.

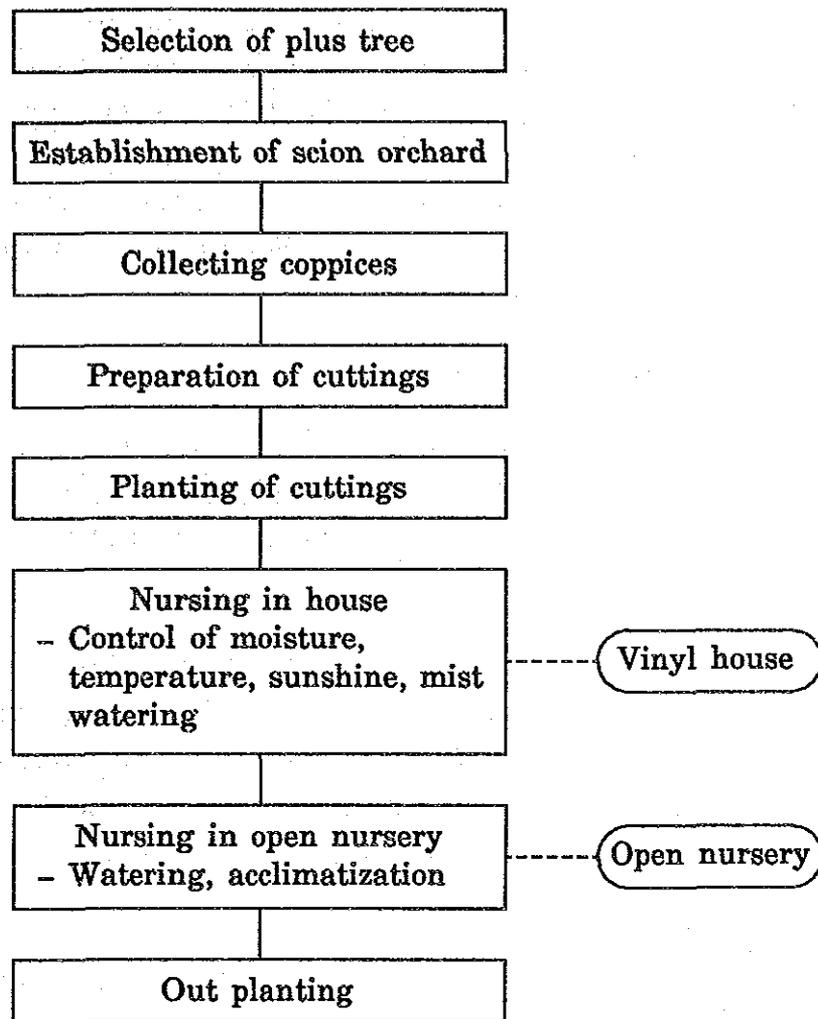


Fig. 4-2-2 Working System of Cuttings

3) Open Nursery

As described in 1) above, the number of original nursery stocks required to obtain 5 million stocks by one nursery center is 5.863 million. The pots commonly used for nursery operation are filled with soil of 6cm in diameter and 12cm in height. An average of 266.5 pots per m² are placed.

The bed frames to place the pots in order can be either a fixed type made of concrete or concrete blocks or a mobile type made of wood or bamboo. The standard internal measurements of a fixed frame are 1m in width and 9m in length and a work path of 0.6m in width is provided between the frames. Given the unit size of 40m × 20m, 44 frames (4 lines × 11 rows) can be created. As 3 water tanks for watering are installed along the central path in each unit, the internal measurement length of 6 frames is reduced to 8.5m (for 3 frames) or 7.7m (for 3 frames). Consequently, the nursery bed size, nursing area and number of pots to be used are as follows.

(Internal Measurements)	(Pots)
1m wide × 9m long × 38 beds = 342.0m ² ; 16 × 150 × 38 beds	= 91,200
1m wide × 8.5m long × 3 beds = 25.5m ² ; 16 × 141 × 3 beds	= 6,768
1m wide × 7.7m long × 3 beds = 23.0m ² ; 16 × 128 × 3 beds	= 6,144
total 44 beds = 390.6m ²	104,112

The number of potted seedlings per unit is approximately 104,100 with the use of fixed frames. The number is 5,205 million for 50 units. Since the required number of nursery stocks is 5.862 million, a 1.13 turnover rate must be achieved.

In other words, 657,000 nursery stocks must be raised in the second operation which can be achieved by nursing the following fast growing species in 2 operations.

<u>Species</u>	<u>Nursing Period</u>	<u>Total Number</u> <u>(1,000)</u>	<u>1st Operation</u> <u>(1,000)</u>	<u>2nd Operation</u> <u>(1,000)</u>
Cassia siamea	3 - 4 months	353	263	90
Acacia sp.	3 - 4 months	1,111	827	284
Eucalyptus sp.	3 - 4 months	1,111	827	284
Total		2,575	1,917	658

The sowing and planting times of the above species are set to allow nursing of 74.5% of the total requirement in the first operation and the remainder in the second operation. The schedule for the planting of the second batch of stocks should be set in late July or early August.

The use of fixed frames for all 50 units makes it difficult to use the space for work other than the nursing of potted cuttings despite the availability of watering and sunshading facilities. A numerical increase of the pots per unit is feasible with the use of bamboo or wood frames. The open nursery can be made into an open nursery for cuttings grown in the vinyl house by removing the shading net and using Hiko blocks. It can be further used for sowing beds for species subject to open culture. In view of these consideration, the installation of frames to only half of the units is deemed appropriate.

4) Potting House

A potting house is a workplace where the medium (soil) is filled into the pots in a systematic manner. The volume of the medium required to fill 5.862 million pots used by one nursery center is calculated as follows.

$$\begin{aligned} \text{medium volume per pot} &= 0.00034\text{m}^3 \\ &= (6/2)^2 \times 3.14 \times 12 \div 1,000,000 \end{aligned}$$

$$\begin{aligned} \text{medium volume for 5.862 million pots} \\ &= 0.00034\text{m}^3 \times 5,862,000 \\ &= 1,993.1\text{m}^3 \\ &\approx 2,000\text{m}^3 \end{aligned}$$

Based on the medium composition and ratio of each component adopted at the RFD nurseries, the required materials to prepare the medium are as follows;

<u>Material</u>	<u>Ratio (%)</u>	<u>Required Volume (m³)</u>
top soil	50	1,000
sand	20	400
rice husk charcoal	20	400
compost	10	200
Total	100	2,000

The medium filling work is carried out between October and March. The average number of working days per year is 120 days and 16.7m³ of medium are potted each day. Assuming one worker is capable of filling an average of 1,200 pots per day, the required work volume is 4,885 man-days which can be broken down to 120 working days with 41 workers per day. The number of workers, however, actually fluctuate depending on the season. The workplace area should

be sufficiently large enough to accommodate up to 52 workers. At full capacity operation, 4 lines of 13 workers are introduced with work tables to fill the pots with the medium which is moved on 2 lines of roller conveyors from the pit. The pots filled with the medium are moved forward on 3 lines of roller conveyors in seedling containers. 5 lines of roller conveyors and 4 lines of work tables require a width of 12m. The transfer of the medium from the pit to the roller conveyors, 13 work tables with chairs and space for the pot cases add up to 22m in length, resulting in a potting house floor area of 480m² (12m × 40m).

A concrete floor of 150m² (10m × 15m) is provided next to the potting house where miscellaneous work, including seed treatment, can be conducted.

5) Compost House

The required volume of compost for 5.862 million pots is 200m³. When rice straw, weeds and cow dung, etc. are used to make compost, 7 - 10 weeks are required for ripening depending on the required degree of ripeness, the materials used and the temperature. Ash and rice husks, however, would require about 3 - 4 months.

The roofed compost house has a wall height of 2.5m and a floor size of 8m in length and 10m in width (80m²). The height of the eaves is 4.1m. The spatial capacity of 200m³ (2.5m × 80m²) is adequate to produce and store 200m³ of compost in 3 rotations. The entrance is as wide as 5m to allow the transportation and stacking of compost materials and the cutting and loading of compost by machines. Floor gutters and a waste water tank are installed to treat the waste water generated by watering.

6) Storage House

A storage house (10m × 10m = 150m²) is provided to store nursery tools and materials, insecticides, fungicides and fertilizers, etc.

7) Seed Solar Dryer

As the solar dryer developed and improved at the Sakaerat Site of the Research and Training in Re-afforestation Project has been proven effective, a dryer with the same function and size is used.

(3) Other Appurtenant Facility

1) Irrigation facility

Since the reservoir is considered to be a reliable water resource in Mahasarakham, Nakhon Ratchasima and Yasothon, a pair of pumps shall be set up at the pump house to take the required volume of water which is then conducted to the distribution tank. In the case of Yasothon, a deep well shall be constructed to take ground water with a submergible pump. The water shall be discharged into a concrete-made distribution tank having a capacity for the daily water requirement. Water supply pipes shall be hard polyvinyl chloride (VP) or its equivalent. The gravity system is not adaptable to distribute water to each nursery unit because the topography of the site is too flat to obtain enough hydraulic pressure. The pressure shall therefore be applied by the pump at the distribution tank in order to supply water to each water tank. Watering shall be done manually.

2) Drainage Facility

Ditches shall be provided on both sides of the road in order to smoothly drain rainwater from the site. It shall be earth - made and designed to be constructed in such a way that conduit pipes are placed in road crossing sections to facilitate water flow. Water collecting system is also provided according to the topographic conditions, and the drain pipes shall be required at the extreme section to protect the land from soil erosion.

3) Road

Access road shall be gravel - paved, but the entrance yard of the main office building shall be concrete. The work road shall be placed strategically to enclose a pair of units of open nursery. Since the land is flat without undulation, the road shall be designed to reduce earth work to the minimum as possible, and its finished surface shall be of the same level as the nursery. The work road is also paved with gravel in order that the vehicles and tractors can approach the nursery for the purpose of promoting work efficiency.