DETAILED DESIGN REPORT
ON
THE PILOT INFRASTRUCTURE IMPROVEMENT WORKS
FOR
THE AGRICULTURAL DEVELOPMENT RESEARCH PROJECT
PHASE II
IN
NORTHEAST THAILAND

March, 1990

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

In response to a request from the Government of the Kingdom of Thailand for Project-type Technical Cooperation to strengthen research activities contributing to agricultural development in Northeast Thailand, the Government of Japan commenced the Agricultural Development Research Project in Northeast Thailand for five years from December 20, 1983. The project aimed at promoting development in the Northeast region, which remained the least developed region in Thailand.

Upon conclusion Phase I of the cooperation period of five years, Phase II has been proceeding in succession for the term of five years from December 1988, aiming to establish a farm management system suited to the specific environmental conditions in Northeast Thailand on the basis of research results which were developed so far.

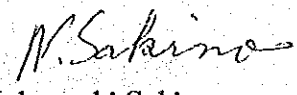
The project has been carried out mainly at the Agricultural Development Research Center (ADRC) in Khon Kaen, which was established through Japanese grant aid. In Phase II, a pilot farm is to be improved as a base for experiments and for demonstration of farm management systems as well as diffusion of research results, which are the purposes of Phase II.

In this connection, the Detailed Design Survey Team on the Pilot Infrastructure Improvement Works for the Agricultural Development Research Project Phase II in Northeast Thailand headed by Mr. Satoshi Ishida, Deputy Director, Project Planning Division, Agricultural Structure Improvement Bureau, Ministry of Agriculture, Forestry and Fisheries, was sent to the Kingdom of Thailand from November 28, 1989 to January 11, 1990 for the purpose of field survey.

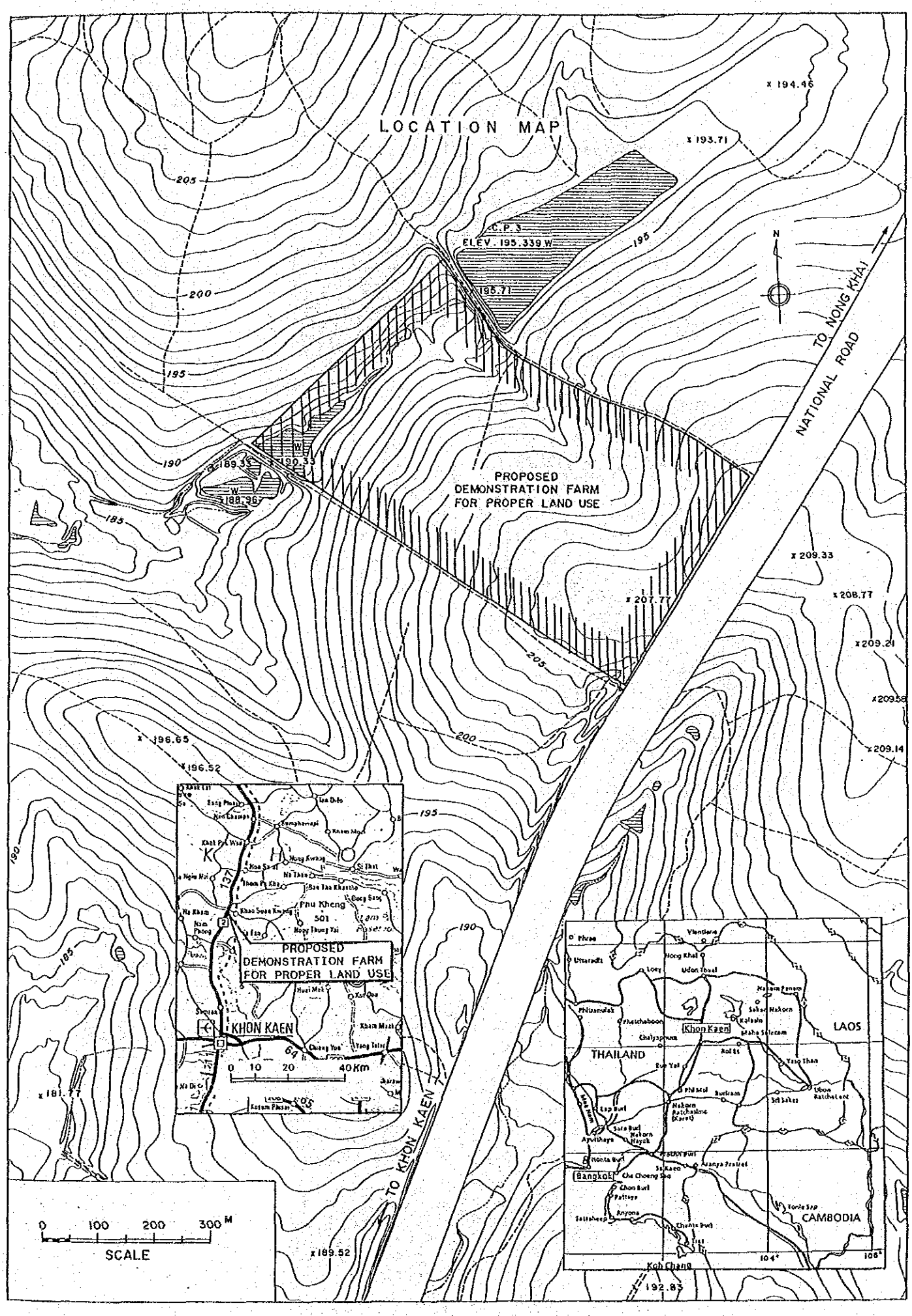
This report presents the results of the field survey and subsequent studies in Japan. I hope that this report will serve as a guideline for scheduled improvement work on the said pilot farm, etc.

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

March, 1990



Nobuyoshi Sakino
Director
Agricultural Development
Cooperation Department
Japan International Cooperation Agency


LOCATION MAP
x 194.46
x 193.71
C.P. 3
ELEV. 195.339 W
195.71
N
TO NONG KHAI
NATIONAL ROAD
PROPOSED
DEMONSTRATION FARM
FOR PROPER LAND USE
x 189.35
x 190.35
W
188.96
x 209.33
x 208.77
x 207.77
x 209.21
x 209.58
x 209.14
x 196.65
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205
200
195
190
185
PROPOSED
DEMONSTRATION FARM
FOR PROPER LAND USE
KHON KAEN
Phu Kheng
0 10 20 40Km
TO KHON KAEN
x 181.77
x 189.52
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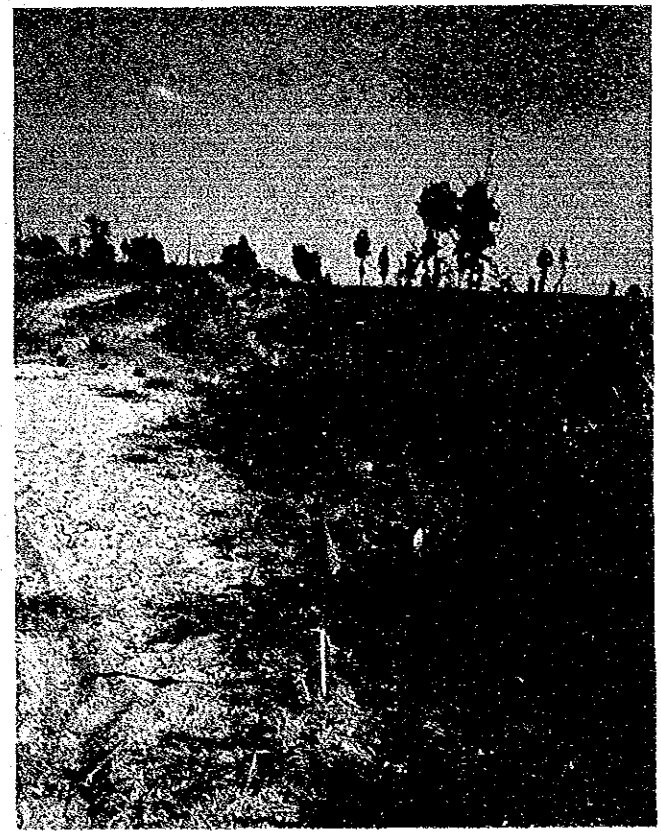
SCALE
THAILAND
LAOS
CAMBODIA
Bangkok
Khon Kaen
Koh Chang
192.85

Topographic Survey

Topographic Survey



Topographic Survey

Soil Erosion in the Site

Soil Erosion in the Site

Soil Erosion and
Sedimentation in the Site

Existing Reservoir

Existing Reservoir:
Erosion of Side Slopes

Existing Reservoir:
Outcrop of Rock

Upper Portion of
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CHAPTER 1. PURPOSE OF THE SURVEY

1.1 Present Conditions of the Northeast Thailand

(1) Natural conditions

The Northeast Thailand is bordered by the Mekong River on the north and the east and by a mountain chain on the south and the west. The area is about 170,000 km^2 and occupies about 33 % of the total country area of about 514,000 km^2. The Northeast adjoins Laos on the north and the east with the boundary of the Mekong River and is bordered on the south by Cambodia. The Northeast is adjacent to the Central Plain of Thailand intervened by a mountain chain of more than 1,000 m high on the west. About 90 % of the Northeast is a flat plateau having ground elevation between 100 m and 500 m. The topography is inclined from the northwest to the southeast.

Climate is influenced by the southwest monsoon and the rainy season begins from the latter half of April. The end of the rainy season differs from place to place: September in the northward from the north latitude 16° and October in the southward. Rain comes line-wise during the first half of the rainy season and area-wise during the latter half. There is a period of few rainfall between the first half and the latter half of the rainy season. The agriculture in Thailand is damaged by this rain interruption. The extent of damages caused by this rain interruption in the Northeast is high compared with other areas. The average annual rainfall in the Northeast is 1,368 mm. The amount of annual rainfall differs from place to place and year to year. The mean temperature in January, the coldest month, is about 20°C, and that in April, the hottest month, is about 30°C.

Forest area in the northeast Thailand occupies about 18 % of the total area of the region in 1978, this figure indicates about a half of the country's average of 34 % . In 1950, the ratio of forest area in the Northeast was about 61 % and it was higher than the country's average. Judging from this, it is obvious that forest area in the Northeast has decreased faster than the other areas. This was caused by a shifting cultivation and a forest felling for firewood. In recent years, flood and drought have been occurred frequently in Thailand, these may be mainly caused by the forest felling.

Alluvial soil which is suitable for farming covers only 6 % of the total area of the Northeast, on the other hand, agricultural areas are about 47 %. There are also many problems of soils in the Northeast: saline soils and soil erosion, etc. Outflow of surface soil by soil erosion is one of the main reasons which makes stable farming difficult in the Northeast.

(2) Socio-economic conditions

The population of the Northeast is 16,090,000 in 1980, and this amounts to about 34 % of the whole population in Thailand. A rate of population increase in the Northeast is 2.02 % (1977-1980) which is higher than that of 1.98 % in the country.

The economy in Thailand has developed under several National Economic and Social Development Plan launched in 1961. The gross domestic product (GDP) reached 846 billion Baht as of 1982 corresponding to the per capita GDP of about 17,450 Baht. The per capita GDP in the Northeast is equivalent to about 40 % of that of the country and about 13 % of the Bangkok area.

Main industry in the Northeast is agriculture. About 89 % of labour force was engaged in agriculture as of 1979. The number of farm households was about 1,770,000 in 1979, which occupied about 40 % of that of the country. Average size of farm household was 5.8 persons as of 1978. About 94 % of farm households is owner cultivator and about 55 % of that is a full-time farmer in the Northeast.

In 1980, land for agricultural use in the Northeast has reached to about 47 % of the total land area of the region, which occupied about 42 % of the total agricultural land area in the country. The extension of land for agricultural use is almost limited in the Northeast. The average farm size was about 28 rai (4.5 ha) as of 1979, which was larger than that of about 26 rai of the country.

The agricultural land use in the Northeast as of 1978 was as follows : 56 % for paddy field, 19 % for upland field, 1 % for orchard and 24 % for glass land, etc. Upland farming is mainly carried out in the areas along the national road (route 2) and its branches. The major crops are maize, cassava, sugar cane, etc. The transportation of upland products to Bangkok has been improved by the road construction, and this has contributed to expand upland field areas.

The cultivated area for maize accounts for about 25 % of that of the country and for cassava for 60 to 65 %. Upland fields are scarcely irrigated in the Northeast and depend upon fainfall mainly. A glutinous rice is produced in the Northeast and its planted area accounts for 65 % of the rice planted area in the region, and for about 83 % of the planted area of glutinous rice in the country. 92 % of paddy field in the Northeast is rainfed which accounts for about 60 % of the rainfed paddy field area in the country.

Agricultural productivities in the Northeast is low : paddy yield of the rainy season was 1.2 ton/ha and that of the dry season was 2.2 ton/ha during the period from 1978 to 1980. These values are about 70 % of the average yield in the country. As for the upland field, the yield of maize was 1.8 ton/ha and that of cassava was 13.2 ton/ha. These values are equivalent to 89 % and 95 % of the average of the country, respectively. The reasons for low agricultural productivities in the Northeast are as follows : agriculture in the Northeast depends on unstable rainfall and agricultural land has been extended on the areas of unsuited soil conditions, etc.

1.2 Outline of the Agricultural Development Research Project Phase II in Northeast Thailand

(1) The Agricultural Development Research Project Phase I in Northeast Thailand

Phase I was intended to strengthen the agricultural research activities in the northeast Thailand for : assessment of natural environment and resources to design plans for proper land use, development of agronomic technology adaptable to each locality and identification and elimination of the existing production constraints. Research subjects were as follows :

1) Assessment of natural environment and natural resources
   i. Land classification and planning land use
   ii. Stochastic analysis of rainfall

2) Improvement of crop performance
   i. Interaction among environment, water stress and crop performance
   ii. Appropriate crops for drought conditions

3) Soil conditions and its improvement
   i. Amelioration of soil salinity
   ii. Recycling of organic materials
   iii. Conservation of soil fertility

Phase I was carried out for five (5) years from December 1983 to December 1988.

(2) Objectives of the Project

Based on the Master Plan which is given in the Record of Discussions (R/D), Phase II aims to strengthen research activities contributing to agricultural development suited to the specific environmental conditions in the northeast Thailand on the bases of results of Phase I. Research activities are decided as follows :

1) Classification of agro-ecological zones and land use planning
   i. Land classification and planning land use
   ii. Zoning by climatic conditions
   iii. Agro-ecological zoning and land use planning

2) Development of farm management system
   i. Farm management on upland suited to each locality
   ii. To develop farm management system on low land suited to each locality

3) Development of low-input technology
   i. Improvement of soil fertility in problem soils
   ii. Management of organic matter
   iii. Development of bio-fertilizers
   iv. Soil and water conservation on crop management
   v. Development of plant propagation technique

(3) Cooperation activities of the Project

Term of cooperation is five (5) years from December 20, 1988 to December 1993. Research activities are performed at the Agricultural Development Research Center (ADRC) and its Annex and at the Field Crop Research Center (Khon Kaen) and its four (4) satellite experimental stations (Kalasin, Maha Sarakham, Roi Et and Loei). Seven (7) Japanese long-term experts are dispatched in principle. Short-term experts are dispatched when necessity arise

for the smooth implementation of the Project. 83 Thai counterparts are assigned to the Project.

(4) Administration of the Project

Thai agencies concerned to the Project are : the Ministry of Agriculture and Cooperatives (MOAC) and the Khon Kaen University (KKU). From the MOAC, three institutions are participating in the Project : the Office of the Permanent Secretary (OPS), the Department of Agriculture (DOA) and the Department of Land Development (DLD). The OPS is responsible for coordination of the Project, and DOA and DLD undertake research works. Organization chart of project implementation is indicated at the end of this section. Outline of committee concerned to project implementation are as follows:

The Coordinating Committee

Chairman of the Committee is Permanent Secretary of the MOAC. The Committee formulates policies and objectives of the Project, and administer the cooperation among Thai institutions involved and the JICA. The Committee also appoints other committee and working group.

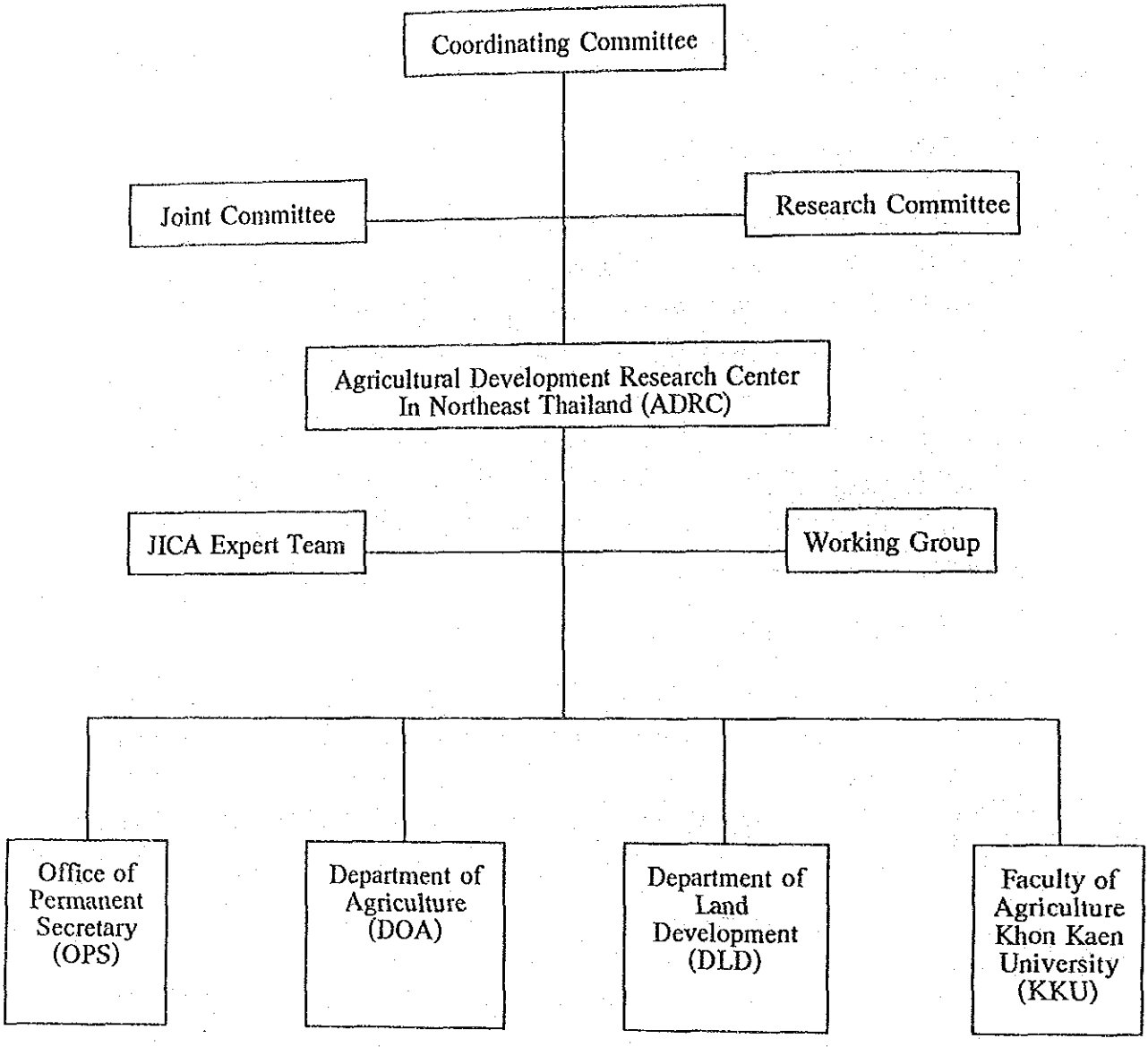
The Joint Committee

Chairman of the Committee is Permanent Secretary of the MOAC. The Committee is held annually and when necessity arises. The Committee formulates annual operation policies for the ADRC in accordance with the Tentative Schedule of Implementation of the Project.

The Committee reviews the progress of technical activities and year accomplishments. Furthermore, the Committee reviews and exchanges views on major issues arising from or in connection with technical cooperation program.

The Research Committee

The Committee formulates operation control in the implementation of project activities from the technical aspects. Under the Committee, the Working Group is set up to coordinate and follow up project activities.



ORGANIZATION CHART OF PROJECT IMPLEMENTATION

1.3 Background of the Survey

The Agricultural Development Research Project Phase I in Northeast Thailand commenced based on the Record of Discussions (R/D) agreed on between the Government of the Kingdom of Thailand and the Japan International Cooperation Agency (JICA) on December 20, 1983. Phase I was carried out for five (5) years from December 1983 to December 1988.

The Agricultural Development Research Project Phase II in Northeast Thailand started based on the R/D signed between the Government of the Kingdom of Thailand and the JICA on December 16, 1988. Term of cooperation of Phase II is five (5) years from December 20 in 1988. Implementation program of Phase II was agreed in the Tentative Schedule of Implementation (TSI) signed on August 17,1989.

In the course of Phase II, the Government of the Kingdom of Thailand planned the Demonstration Farm for Proper Land Use (the Farm) to experiment and demonstrate the farming techniques, which were developed so far, and requested the Government of Japan to provide the cooperation for the plan. In response to the request, the Government of Japan has decided to improve the Farm by the Pilot Infrastructure Improvement Works and to conduct the Detailed Design Survey (the Survey).

1.4 Objectives of the Farm

Objectives of the Farm are to :

(1) undertake the experiment / trials to check the techniques, which were developed so far, on their adaptability to local conditions, and

(2) develop and demonstrate proper land use system to improve soil productivity under the conditions of typical topography of the Northeast.

The Farm, therefore, will play the important role for research and technology transfer to the farmers as a project activity of the technical cooperation. The Farm will be operated and managed by the Agriculture Development Research Center (ADRC).

1.5 Objectives of the Survey

Objectives of the Survey are to conduct the Detailed Design Survey for the improvement of the Farm, including land consolidation, irrigation and drainage facilities, farm road, reservoir, farm facilities, etc.

1.6 Survey Area

Survey area covers about 25 ha of national land in Khao Suan Kwang, about 40 km north of Khon Kaen.

CHAPTER 2. PRESENT CONDITIONS OF THE SURVEY AREA

2.1 Location and Scale of the Farm

The Farm site is located immediately to the west of the Khon Kaen - Udon Thani Highway, about 40 km north of Khon Kaen. The Farm lies within Changwat Khon Kaen, Amphur Khao Suan Kwang, Tambon Khao Suan Kwang administratively. The location of the Farm is planned in consideration of soil type, rainfall, topographic features and efficiency for demonstration. The scale of the Farm is about 25 ha including the facilities yard.

2.2 Topography

Topographic survey at the Farm site was performed on the following items, based on the existing topographic map of 1/1,000 scale with 0.5 m contour, which had been drawn by the Department of Land Development (DLD) :

(1) traverse surveying along the boundary of the Farm
(2) drainage canal route surveying
(3) farm road route surveying
(4) profile and cross sectional levelling at the reservoir site, and
(5) contour line check surveying, etc.

New topographic map was made based on the survey results by revising the existing one on the detailed portion. The highest portion of the Farm is the southeast side along the notional road and the lowest portion is the northwest side around the reservoir. The gradient of the original ground surface is 2° to 3° on average.

2.3 Water Quality

Water sampling from the existing reservoir was carried out and water quality was analyzed. The results of test are as follows:

Electrical Conductivity EC (ms)	pH Value pH	Suspended Solids SS (ppm)
1.1	7.1	95

Note) Sampling date : Dec. 12, 1989

According to the results, it is concluded that water quality at the site is suitable as irrigation water.

2.4 Soils

Soils were surveyed by excavating two (2) test pits (STP.1 and STP.2). According to the results, soils in the Farm are as follows:
(The detail is attached in Appendix.)

(1) Upper portion

A horizon : sandy loam with thickness of 15 - 20 cm

B horizon : strong brown to yellowish red or red sandy clay loam, no ironstone within 150 cm

(2) Middle portion

A horizon : loamy sand and/or sandy loam with thickness of not more than 50 cm

B horizon : strong brown to red sandy clay loam included ironstone more than 35 % of volume between the depth of 50 - 150 cm

(3) Lower portion

A horizon : sand or loamy sand with thickness of 50 - 80 cm

B horizon : sandy clay loam with ironstone between the depth of 50 - 150 cm

(4) Eroded areas at middle and lower portion

A horizon : sand or loamy sand with thickness of not more than 50 cm

B horizon : ironstone or bed rock of sandstone within 50 cm from the surface

2.5 Soil Mechanics and Foundation

Soil mechanics and foundation survey was carried out as a basis of the design and construction plan of the reservoir. This survey was performed as follows:

(1) three (3) test pitting (TP.1, TP.2 and TP.3) and
(2) seven (7) auger boring (AH.1 to AH.7)

Foundation survey and soil mechanical test of typical soils were executed by using these holes. (Detailed survey results are indicated at Appendix.)

It can be concluded from the survey that the foundation is considerably undulating sandstone and clay with gravel, clay, sand, etc. are sedimented on the foundation . It is estimated that the foundation is continuous to sandstone cropped out in the existing reservoir. Water in the existing reservoir is not exhausted even during the dry season, therefore, it is presumed that a change of groundwater table is small.

2.6 Geology

Geologic age of the foundation is the Mesozoic Cretaceous Era. The foundation is white cross-bedded sandstone which belongs to the Phu Phan Formation.

2.7 Climate

The weather station nearest to the Farm is located at Khon Kaen and the climate conditions in Khon Kaen (from 1956 to 1985) are described below:

The average annual rainfall is 1,176.7 mm. The rainy season is five (5) months from May to September, as shown in the table below. The total amount of rainfall during the rainy season is 962.7 mm and this accounts for about 82% of the annual rainfall. The maximum monthly rainfall is 262.0 mm in September and the minimum is 3.3 mm in December. The average number of rainy days in a year is 105.5 days and 79.6 days are distributed during the rainy season. The number of rainy days in a month during the rainy season is 13.6 to 18.2 days.

(Unit : mm)

Month	Jun.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Monthly Rainfall	4.6	13.2	31.1	60.7	167.7	176.9	163.4	192.7	262.0	87.2	13.9	3.3

The annual mean temperature is 26.8°C. The maximum monthly mean temperature is 30.1°C in April and the minimum is 22.8°C in December and January. The temperature rises from January to April and drops gradually from April to December. The maximum daily temperature is over 40° between February and May and the minimum is about about 6°C during January and December.

The annual average relative humidity is 70.8%. The maximum monthly mean relative humidity is 82.0% in September and the minimum is 59.3% in March.

The annual evaporation is 2,020.2 mm (average 5.5mm/day) and monthly evaporations are shown below. A typhoon hardly attacks in the Northeast.

(Unit : mm)

Month	Jun.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Total	154.2	161.4	211.7	216.6	196.5	171.4	165.5	150.0	137.0	152.3	151.0	152.4
Daily Average	5.0	5.8	6.8	7.2	6.3	5.7	5.3	4.8	4.6	4.9	5.0	4.9

Note) Instrument; A-pan

2.8 Hydrology

(1) River basin

Drainage area is about 1 km^2, which consists of upland and paddy field.

(2) Runoff

Discharge measurements in and around the river concerned have not been carried out. The ratio of surface runoff to annual rainfall is estimated at about 15% from the existing data , etc.

(3) Rainfall intensity

Probable rainfall intensity curves at Khon Kaen and Udon Thani are shown in Appendix. The rainfall intensity at Udon Thani is greater than that of Khon Kaen.

2.9 Intake Rate

Intake rates were measured by using the double ring infiltrometer at four (4) points (IR.1 -IR.4) on the site. The results are as follows: (The detail is shown at Appendix.)

(Unit : mm/hr)

Survey Point	Basic Intake Rate (Ib)
IR.1	62.6
IR.2	48.8
IR.3	56.3
IR.4	132.4

2.10 Electricity and Water Supply

Transmission line of 22,000-volt current (50 Hz) is installed along the national road and it is possible to take electric power from the transmission line. Water supply steel-pipe of 450 mm in diameter is installed along the national road, however, it is impossible to draw water from the pipe.

CHAPTER 3. PLAN OF THE FARM

3.1 Components of the Farm

Components of the Farm are planned as follows :

(1) Farm fields

1) Fields
   - Irrigation field
   - Soil erosion survey field
   - Land use demonstration field
2) Runoff plots (for measuring soil loss and runoff water)
3) Reservoir
4) Pump and pump station
5) Water supply pipeline
6) Water tank
7) Irrigation water supply system
8) Drainage canal
9) Farm road

(2) Farm facilities

1) Field laboratory
2) Machinery store-house
3) Survey and storage house
4) Dry yard

3.2 Farm Fields

The Farm consists of the following fields and related constructions:

(1) Field

The area of the experimental and demonstration fields is about 19 ha.
The farm consists of the following three kinds of field:

1) Irrigation field

The area of the irrigation field is about 5.6 ha. This field is used for experimental activities related to irrigation.

2) Soil erosion survey field

The area of the soil erosion survey field is about 0.5 ha. This field equips runoff plots for measuring soil loss and runoff water.

3) Land use demonstration field

This field is about 13 ha. In the field, the technology developed by the Project is systematized for demonstration to the farmers.

(2) Runoff plots

Eighteen runoff plots for measuring soil loss and runoff water are constructed in the soil erosion survey field. Size of the runoff plot is 5 m width and 20 m length.

(3) Reservoir

Aiming to develop and demonstrate proper land use system with supplemental irrigation during the rainy season (May - September) and irrigation during the dry season (October - April), the reservoir is planned as a water resource for these irrigation purposes. Discharges of the river, water resource of the Farm, are estimated to stop during the dry season as well as discontinuation of rainfall during the rainy season. Therefore, a reservoir is necessary in this plan. Storage capacity of existing reservoir has been surveyed to be about 6,000 m^3. Additional storage capacity from the excavation, etc., is planned at 19,000 m^3. Therefore, the reservoir has a capacity of 25,000 m^3. This capacity is enough to irrigate whole irrigation field during the rainy season. On the other hand, about 30 - 40 % of irrigation field area is to be irrigated during the dry season.

(4) Pump and pump station

Pumping system is planned because the reservoir is located at the lowest portion of the Farm area. Pump station is installed on the site which is suitable to intake the low water in the reservoir. Electricity is considered as power for pump.

Pump type is selected as horizontal single suction multi-stages volute pump (ϕ 50 mm).

(5) Water supply pipeline

This facility is used for conveying irrigation water from pump station to water tank. The pipeline is designed as a closed system. Total length of the pipeline is about 530 m.

(6) Water tank

In case of upland irrigation by pumping, installation of water tank is desirable in the system of water supply. With this consideration, the water tank is planned to be installed on the highest portion of the Farm. The capacity of the water tank is planned to be 65 m^3.

(7) Irrigation water supply system

Irrigation water is conveyed by gravity from water tank to hydrants on field through this facility. In order to utilize pumped irrigation water and water head effectively, closed type pipeline system is planned. Pipeline system is also recommendable from the viewpoint of topographic gradients. Total length of the system is about 960 m.

(8) Drainage canal

Drainage canal is planned to protect the Farm from gully erosion caused by rainfall. Drainage canal is designed as wide grassed waterways. Gabionades are placed in the canal to control the drainage hydraulics. Total length of the canal is about 1,500 m.

(9) Farm road

Farm road is planned in the Farm for easy approach by machinery and for maintenance works. Main farm road is designed at 5 m of width and about 440 m of length in total. Branch farm road is 4 m width and about 1,690 m length in total.

3.3 Farm Facilities

In order to conduct experiment and demonstration activities in the Farm, following facilities are planned:

(1) Field laboratory

Field laboratory equips those such as

- laboratory for farming researches,
- laboratory for soil researches, and
- equipment room.

The laboratory is constructed with concrete block wall and slate roof. Total floor area is 144 m^2.

(2) Machinery store-house

Machinery store-house stores vehicle and agricultural machinery, such as tractor, etc. Total floor area is 72 m^2. The house is constructed with steel pillar and slate roof, but without wall.

(3) Survey and storage house

Survey and storage house equips those such as

- preliminary survey room,
- fertilizer and chemical storage, and
- products storage.

The house is constructed with concrete block wall and slate roof. Total floor area is 192 m^2.

(4) Dry yard

In order to dry agricultural products, such as cassava, cowpea and beans, etc., dry yard is constructed. The yard is planned as the area of 216 m^2 with concrete pavement.

CHAPTER 4. DETAILED DESIGN

4.1 Design Conditions and Design Criteria

(1) Field

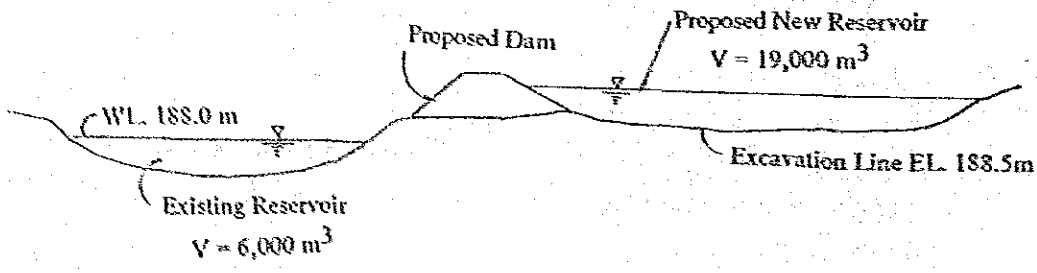
As the present inclination of the field is from 2° to 3°, cutting and banking are not carried out in principle. Half the irrigation field of upper portion is designed to be irrigated by drip, and lower portion by sprinkler.

(2) Runoff plots

Gradient of inclined uplands ranges almost 1° to 5° in the Northeast. Within this gradient, uplands with inclination between 3° and 5° are damaged by soil erosion considerably. Based on the above, inclination of runoff plots is planned to be 3° and 5°. Areas of the runoff plots are designed to be irrigated by hose.

(3) Reservoir

The existing reservoir has storage capacity of 6,000 m^3. Total storage capacity is designed at 25,000 m^3 in this design under restrictions of topographical and geological conditions and budget. Therefore, it is necessary to obtain the additional storage capacity of 19,000 m^3. In the upper stream area, it is estimated that the foundation is comparatively shallow according to the survey. Therefore, designed storage capacity is obtained by construction of the dam, as shown below, as well as the existing reservoir capacity, because it is hard to make the required additional capacity by excavating merely the upper stream area.



Excavation line of new reservoir bottom is decided at EL. 188.5 m based on the estimated foundation conditions studied by the results of the survery. Based on

the above, full water level is designed at EL. 190.5 m in order to make the storage capacity of 19,000 m^3.

1) Design flood discharge

Design flood discharge (Qd) of the dam is calculated by the rational formula as follows:

$$Qd = \frac{1}{3.6} f \cdot r \cdot A (m^3/s)$$

$$= 18.3\ m^3/s$$

where; f : coefficient of discharge (0.6)
r : rainfall intensity (110 mm/hr)
A : drainage area (1.0 km^2)

2) Overflow depth of spillway

Spillway is constructed in the middle of river channel considering the geographical features. This spillway is made of concrete. The overflow depth (Hd) is calculated by the following formula :

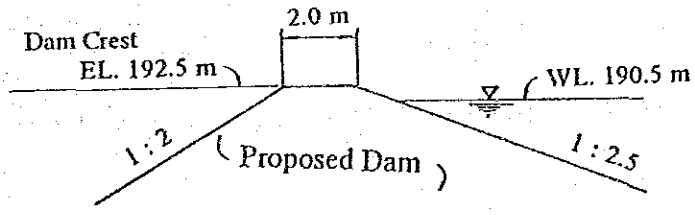
$$Hd = \left(\frac{Qd}{C \cdot L}\right)^{2/3}$$

$$= 1.0\ m$$

where; C : coefficient of overflow (1.8)
L : length of weir (10.0 m)

3) Dam plan

Axis of dam is (6) - (6) line on the survey map attached. Height of freeboard is designed at 1.0 m. The cross section of dam is shown below :



Excavated soils from the new reservoir site are utilized as the embankment materials of the dam. Clayey soils are adopted as the embankment materials.

(4) Pump

1) Suction water level

Design water level	EL. 186.0 m (low water level)
High water level	EL. 188.0 m

2) Discharge water level

Design water level	EL. 209.2 m (high water level)
Low water level	EL. 207.2 m

3) Actual head

Design head	23.2 m (maximum head)
Minimum head	19.2 m

4) Design maximum pumping water requirement

Design daily water consumption	7 mm/day
Irrigation efficiency	80 %
Irrigation area	6 ha
Irrigation method	drip 3 ha, sprinkler 3 ha
Ratio of wet area by drip irrigation	0.5
Design maximum pumping water requirement	394 m^3/day

5) Number of Pump 1

6) Pump operation hour 24 hours

7) Design pump discharge 0.27 m^3/min

8) Motive Power Electrically powered

9) Operation control system Water level control in water tank

(5) Water supply pipeline

Water conveyance system is designed to be closed type pipeline and designed buried depth is 0.7 m.

(6) Water tank

Daily irrigated hour	20 hours
Volume of water tank	65 m^3 (adjustable in 4 hours)
Shape	Rectangle (5 m x 6.5 m) Reinforced concrete structure
Elevation of bottom of water tank	EL. 207.0 m
Design low water level	EL. 207.2 m
Design high water level	EL. 209.2 m
Elevation of top of water tank wall	EL. 209.5 m
Effective depth	2.0 m
Height of side wall	2.5 m

(7) Irrigation water supply system

Water distribution system is designed to be closed type pipeline and designed buried depth is 0.7 m. Hydrants (angle valve) are installed in every 20 m.

(8) Drainage canal

1) Design drainage discharge

The magnitude of design rainfall is planned to be 5-year return period, and the average value of rainfall intensities of Khon Kaen and Udon Thani is adopted for the design rainfall intensity. The time of concentration is estimated at about 10 minutes in this design. The design rainfall intensity is estimated at about 110 mm/hr. The design drainage discharge is calculated by the following rational formula:

$$Q = 0.2778 \, f \cdot r \cdot A$$

where;
- Q = Peak discharge (m^3/sec)
- f = Runoff coefficient (0.6)
- r = Design rainfall intensity (110 mm/hr)
- A = Drainage area (km^2)

The design drainage discharge per one ha is estimated at 0.18 m^3/sec/ha.

2) Drainage canal

Widened grassed waterways are constructed. Velocity of drained water is controlled by installing gabionades in canal. Allowable maximum average velocity is designed at 0.6 m/sec.

(9) Farm road

Present topographical gradient is 4 to 5 % which is adoptable as the longitudinal slope of the farm road. The width of main and branch road is 5 m and 4 m, respectively. Farm roads are paved with laterite with the thickness of 10 to 15 cm.

(10) Field laboratory

Field laboratory equips laboratory for farming researches (45 m^2) and soil researches (45 m^2) and equipment room (42 m^2), etc. Total area is about 155 m^2. Wall is constructed by concrete blocks and roof by slates.

(11) Machinery store-house

This house is a garage with a floor area of 72 m^2 (12 m x 6 m). The house has steel column and slate roof.

(12) Survey and storage house

The house has three rooms : preliminary survey room (90 m^2), fertilizer and chemical storage (48 m^2) and products storage (48 m^2). The total area is about 200 m^2. Wall is constructed by concrete blocks and roof by slates.

(13) Dry yard

The yard is paved with concrete (10 cm thick). The area of the yard is 216 m^2 (18 m x 12 m).

4.2 Hydraulic Calculation

(1) Pump

1) Total pump head

Discharge	0.0045 m^3/sec (0.27m^3/min)
Diameter of water pipe	80 mm (0.005 m^2)
Velocity	0.9 m/s
Velocity head	0.041 m
Head loss around pump	0.9 m

$\lambda = 0.0366$

$$h = 0.0366 \times \frac{40}{0.08} \times 0.041 = 0.750 \text{ m}$$

other loss about 20 %

Head loss of water pipe	11.2 m

$$h = 10.666 \times 0.0045^{1.85} \times 100^{-1.85} \times 0.08^{-4.87} \times 500$$

$$= 10.650 \text{ m}$$

other loss about 5 %

Total head	35.3 m (Actual total head 23.2 m)

2) Pump model and caliber

Pump model	Horizontal single suction multi-stages volute pump (50 Hz)
Pump caliber	50 mm

3) Output of motive power

$$P = \frac{0.163 \times 1.0 \times 0.27 \times 35.3}{0.52} \times 1.15 < 3.7 \text{ KW}$$

4) Elevation of pump installed

EL. 190.0 m

(2) Water supply pipeline

Diameter of pipeline	ϕ80 mm
Hydrostatic pressure	1.92 kg/cm^2
Water - hummer pressure	1.92 kg/cm^2 (100% of hydrostatic pressure)
Design water pressure	3.84 kg/cm^2
Type of water pipe	Steel pipe

(3) Main irrigation water supply system

1) System capacity

Daily irrigated hours	20 hours
Daily design water consumption	7 mm/day
Irrigation efficiency	80 %
System capacity (drip, 3ha)	36.5 l/min/ha
System capacity (sprinkler, 3ha)	72.9 l/min/ha

2) Type of water pipe — Hard vinyl chloride pipe

3) Hydraulic calculation

Station	Distance (m)	Water Discharge (m^3/sec)	Diameter of Water Pipe (mm)	Velocity (m/sec)	Head Loss (m)	Hydraulic Water Level (m)
Water Tank	0	-	-	-	-	L.W.L. 207.20
Diverging Point	150	0.0055	ϕ125	0.45	0.30	206.90

(4) Irrigation water supply system for runoff plots

1) Calculating conditions

Area of runoff plots	100 m^2 (5mx20m) x 18 plots
Design irrigation interval	2 days
Irrigation water discharge	14/0.8 = 17.5 mm
Irrigated hours for one plot	2 hours
Irrigation method (proposed)	Hose (Polyethylene pipe, ϕ 25 mm)
Irrigation density	8.8 mm/hr
Allowable irrigation density	12.5 mm/hr
Pressure	0.2 kg/cm^2

2) Type of water pipe — Hard vinyl chloride pipe

3) Hydraulic calculation

Station	Distance (m)	Water Discharge (m^3/sec)	Diameter of Water Pipe (mm)	Velocity (m/sec)	Head Loss (m)	Hydraulic Water Level (m)	Water Pressure (kg/cm^2)
Diverging Point	0	-	-	-	-	206.90	-
End of Water Supply Pipe (EL.204.5)	150	0.00024	ϕ 50	0.12	0.15	206.75	0.22

(5) Lateral irrigation water supply system

1) Calculating conditions for sprinkler irrigation

Design irrigation interval		2 days
Irrigation water discharge		14/0.8 = 17.5 mm
The number of transfer times		5 times/day
One irrigated hours		4 hours
Sprinkler	Nozzle caliber	3.2 x 2.4 mm
	Pressure	1.0 kg/cm^2
	Sprinkling water discharge	10.0 l/min
	Sprinkled diameter	20.7 m
	Irrigation density	4.96 mm/hr
Sprinkler interval x Span		11 x 11 m
Allowable irrigation density		20 mm/hr
Water supply pipe capacity		
	Right branch	73.3 l/min
	Left branch	146.7 l/min
Lateral line capacity		
	Right branch	50 l/min
	Left branch	90 l/min
Lateral line friction loss		
	Right branch (ϕ50mm)	0.01 kg/cm^2
	Left branch (ϕ50mm)	0.05 kg/cm^2

2) Calculating conditions for drip irrigation

Irrigation water discharge		7/0.8 = 8.8 mm
Daily irrigated hours		20 hours
Drip tube	Pressure	0.3 ~ 0.5 kg/cm^2
	Dripped water discharge	6 l/hr/tree

Lateral line water discharge
Right branch — 36.7 l/min
Left branch — 73.3 l/min

Filter — Installation between hydrant and drip tubes

3) Type of water pipe — Hard vinyl chloride pipe

4) Hydraulic calculation

Right branch

Station (Elevation)	Distance (m)	Water Discharge (m^3/sec)	Diameter of Water Pipe (mm)	Velocity (m/sec)	Head Loss (m)	Hydraulic Gradient (%)	Hydraulic Water Level (m)	Water Pressure (kg/cm^2)
Diverging Point	-	-	-	-	-	-	206.90	-
A (EL.201.2)	90	0.0018	φ75	0.41	0.28	0.3	206.62	0.54
B (EL.196.5)	155	0.0018 (0.0012)	φ75	0.41	0.49	0.3	206.13	0.96
C (EL.191.5)	85	0.0012	φ65	0.36	0.26	0.3	205.88	1.44

Left branch

Station (Elevation)	Distance (m)	Water Discharge (m^3/sec)	Diameter of Water Pipe (mm)	Velocity (m/sec)	Head Loss (m)	Hydraulic Gradient (%)	Hydraulic Water Level (m)	Water Pressure (kg/cm^2)
Diverging Point	-	-	-	-	-	-	206.90	-
D (EL.200.5)	120	0.0037	φ125	0.30	0.12	0.1	206.78	0.63
E (EL.196.5)	110	0.0037 (0.0024)	φ100	0.47	0.33	0.3	206.45	1.00
F (EL.191.5)	90	0.0024	φ75	0.55	0.48	0.5	205.97	1.45

4.3 Structural Calculation

Structural calculations for water tank are shown below :

(1) Load

1) Dead weight

Reinforced concrete	2.4 t/m^3

2) Hydrostatic pressure

Internal hydrostatic pressure	2.5 m

(2) Reaction

It is assumed that the reaction on bottom base is distributed uniformly.

(3) Width of member

Side wall	25 cm
Bottom base	35 cm

(4) Shearing force(S) and bending moment(M)

1) Shearing force and bending moment acting on the inside of the side wall
(H : depth from the top of the side wall)

when H is 1.5 m,	S = 1.125 t/m,	M = 0.563 t-m/m
when H is 2.5 m,	S = 3.125 t/m,	M = 2.604 t-m/m

2) Reaction

Section parallel to a short side	WR = 0.571 t/m
Section parallel to a long side	WR = 0.444 t/m

3) Sharing force and bending moment acting on the inside of the bottom base
(X : distance from the center of the side wall)

Section parallel to a short side

when X is 0 m,	S = 1.5 t/m,	M = 2.604 t-m/m
when X is 2.625 m,	S = 0 t/m,	M = 4.571 t-m/m

Section parallel to a long side

when X is 0 m,	S = 1.5 t/m,	M = 2.604 t-m/m
when X is 3.375 m,	S = 0 t/m,	M = 5.133 t-m/m

(5) Allowable stress intensity

Concrete strength after 28days	210 kg/cm^2
Allowable stress intensity of reinforced concrete	
Bending and compression	70 kg/cm^2
Shearing	4.2 kg/cm^2
Bond (deformed bar)	15 kg/cm^2
Allowable tensile stress intensity of reinforcement	1,800 kg/cm^2 (SD30)
Covering	5 cm

(6) Stress calculations

1) Side wall (H = 1.5 m)

The main reinforcement is determined by an amount of the minimum reinforcement.

2) Side wall (H = 2.5 m)

Arrangement of inside main reinforcement	D16 @ 150
Ratio of reinforcement	p = 0.00664
Neutral axis ratio	k = 0.358
Ratio of length	j = 0.881
Concrete compressive stress intensity	σc = 41.3 kg/cm^2
	< σa = 70 kg/cm^2
Concrete shearing stress intensity	τ = 1.8 kg/cm^2
	<τa = 4.2 kg/cm^2
Reinforcement tensile stress intensity	σs = 1,114 kg/cm^2
	< σsa = 1,800 kg/cm^2
Reinforcement bond stress intensity	τo = 5.3 kg/cm^2
	< τoa = 15 kg/cm^2

3) Center of bottom base (calculated in a section parallel to a long side)

Arrangement of inside main reinforcement	D16@150
Ratio of reinforcement	p=0.00442
Neutral axis ratio	k=0.304
Ratio of length	j=0.899
Concrete compressive stress intensity	σc=41.7 kg/cm^2
	<σa=70 kg/cm^2
Reinforcement tensile stress intensity	σs=1,560.5 kg/cm^2
	<σsa=1,800 kg/cm^2

(7) Minimum amount of reinforcement

Side wall	7 cm^2
Bottom base	9 cm^2

The above values are adopted for an amount of transverse reinforcement, too.

CHAPTER 5. COST ESTIMATE

Project cost is summarized in this chapter. Exchange rate of 5.6 yen to the Baht as of December 1989 is adopted for the estimate. Bill of quantity and unit cost are attached to Appendix 6. (5).

Summary Table of Improvement Works

Item	Quantity		Remarks
1. Reservoir Works			Storage Capacity 25,000 m3
a. Excavation	19,000	m^3	
b. Dam Embankment	1,726	m^3	
c. Spillway	1	LS	
2. Drainage Canal Works			
a. Total Length	1,500	m	
b. Drops	132	nos	Gabionades
c. Slope Protection	3,000	m^2	Sod Facing
3. Farm Road Works			
a. Main Farm Road	434	m	Width: 5m, Laterite Pavement
b. Branch Farm Road	1,693	m	Width: 4m, Laterite Pavement
4. Field Grading	6	ha	Grading and spreading spoil soils
5. Irrigation Facilities			
a. Water Supply Pipeline	530	m	Steel Pipe, ϕ 80 mm
b. Irrigation Water Supply System	960	m	Vinyl Chloride Pipe, ϕ50-ϕ125 mm
c. Pump Station	1	LS	Volute Type, 0.27 m^3/min, 3.7kw
d. Water Tank	1	nos	5m (W) x 6.5m (L) x 2.5m (H)
6. Runoff Plots Works	18	nos	
7. Building Works			
a. Building	3	nos	Field Laboratory 155m^2
			Survey and Storage House 200m^2
			Machinery Store-House 72m^2
b. Dry Yard	1	nos	18m x 12 m
8. Transmission Line Works	1	LS	Within the Farm Site

PROJECT COST

I.	Direct Cost			
	[1] Reservoir			1,603,000 ฿
	Capacity		25,000 cum	
	Excavation		19,000 cum	
	[2] Drainage Canal			713,000 ฿
	Length		1,500 m	
	Gabionade		132 pt	
	[3] Farm Road			283,000 ฿
	Main Road	Width	5 m	
		Length	434 m	
	Branch Road	Width	4 m	
		Length	1,693 m	
	[4] Finishing of Field		6 ha	114,000 ฿
	[5] Irrigation Facilities			1,061,000 ฿
	Pumping up pipe	ø80, 530 m		
	Distributing pipe	ø125 - ø50, 960 m		
	Volute pump	0.27 m^3/min, 3.7 kW		
	Water tank	5 m x 6.5 m x 2.5 m		
	[6] Run-off Plots		18 set	207,000 ฿
	[7] Buildings			2,455,000 ฿
	Laboratory, Storage, Garage, Dry yard			
	[8] Electric Line			130,000 ฿
	Sub-total			6,566,000 ฿
II.	Indirect Cost		20%	1,313,000 ฿
III.	Reserve Fund			788,000 ฿
IV.	Others			260,000 ฿
	Total			8,927,000 ฿
	1 ฿ = 5.6 Yen			¥49,991,000

(It is based on the rate at December, 1989)

CHAPTER 6. CONSTRUCTION PLAN

6.1 Construction Plan

(1) Major improvement works

Major improvement works are itemized as follows:

(1) Reservoir works
(2) Irrigation facilities works
(3) Drainage canal works
(4) Farm road works
(5) Field grading works
(6) Runoff plots works
(7) Building works

These works are classified into following three categories from the viewpoint of work plan: civil works (reservoir, drainage canal, farm road, field grading and runoff plots works), irrigation facilities works and building works. Therefore, above three kinds of engineers are required in the working team.

(2) Period of works

Expected construction period is seven months including contract procedures as shown in the figure of construction schedule. Construction during the dry season is preferable to that during the rainy season. However, expected construction term is planned from August to March of the next year in consideration of the Japanese fiscal year.

(3) Soil diversion scheme

Excavated soils of reservoir works are arranged for placement around the reservoir, embankment of the farm road around the reservoir, embankment of the dam, scattering on the field and embankment of building site. Appropriate clayey soils are selected for embankment materials of the dam, and suitable soils for farming for scattering materials on the field. Soils produced by drainage canal excavation are used for the farm road embankment and/or scattering on the field. No carrying excavated soils out from the site is planned.

(4) Construction equipment

The following construction equipments are necessary for the improvement works:

Bulldozer (11 ton)	Reservoir excavation (surface soil), field grading, farm road embankment and other earth works
Bulldozer (15 ton)	Reservoir excavation, carriage of spoil soils (short distance), leveling of spoil-bank
Back hoe (0.35 m^3)	Drainage canal excavation
Back hoe (0.75 m^3)	Reservoir excavation
Tractor shovel (1.2 m^3)	Loading soils
Dump truck (8 ton)	Carriage of spoil soils

(5) Construction plan

The tentative construction schedule is attached.

6.2 Construction Works

(1) Reservoir works

Central main road is used as a construction road, and reservoir excavators are carried into the site firstly. Excavated soil is dealed as mentioned in the section 6.1(3). A portion of the excavated soil is conveyed to the building site, and the site is leveled to start the construction works. Spillway works are executed in consideration of other concrete works.

(2) Drainage canal works

Drops of gabionades are installed in canal in order to reduce the velocity and to control the erosion. Gabionades are made in the site because it is hard to obtain ready-made ones. Sod facing is adopted as slope protection.

(3) Farm road works

Farm road is embanked a little higher than the original ground surface, or constructed by using the excavated soils of drainage canal paralleled to the road.

Large scale cutting and banking are not designed in order to avoid soil erosion. Farm road is paved by laterite. The portions of the farm road across the drainage canal are paved with cobble stones and concrete, so as to use the portions for both purposes.

(4) Field grading works

Spreading spoil soils, grading and levelling by bulldozer are carried out without large scale cutting and banking.

(5) Irrigation facilities works

Pump installation and water tank works are subject to the spoil soils works after reservoir excavation, so the work schedule is determined in consideration of the construction plan.

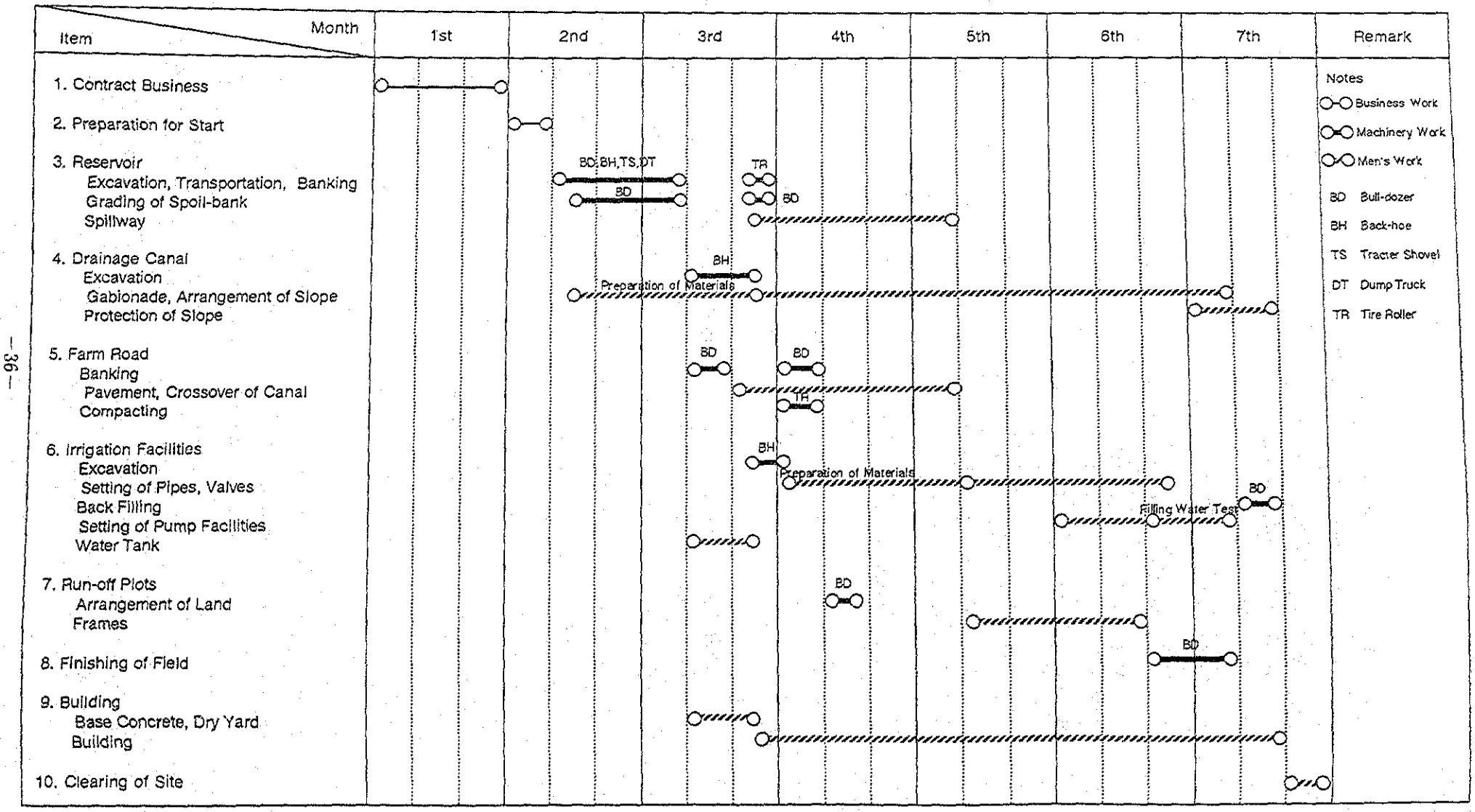
(6) Runoff plots works

Plots are finished at the designed inclination.

(7) Building works

After finishing the embankment at building site, building works are carried out independently. Foundation works are planned not to be flooded below floor level. Pillars of reinforced concrete, roof beams of steel frames and walls of concrete blocks, etc. are planned in the design.

Construction Schedule



CHAPTER 7. CONTRACT DOCUMENTS

BID DOCUMENTS

FOR

CONSTRUCTION WORK OF THE DEMONSTRATION FARM

ON

THE AGRICULTURAL DEVELOPMENT RESEARCH PROJECT

PHASE II

IN

NORTH-EAST THAILAND

JAPAN INTERNATIONAL COOPERATION AGENCY

THAILAND OFFICE

CONTENTS

JAPAN INTERNATIONAL COOPERATION AGENCY

THAILAND OFFICE

INVITATION TO BID NO._____

The Japan International Cooperation Agency, Thailand Office hereby invites sealed written bids for the Construction Work of The Demonstration Farm on the Agricultural Development Research Project Phase II in North-East Thailand (hereinafter referred to as "the Project") which is situated in Khao Suan Kwang, Khon Kaen, 40280. The project has a total area of about 25.0 ha.

This Contract will include, among others, the following ;

1. Terms and Conditions of this Contract
2. Pledge Agreement
3. Technical Specifications
4. Bill of Quantities
5. Drawings

Bid shall be addressed to _____, Resident Representative, Japan International Cooperation Agency, Thailand Office, 1674/1, New Petchburi Road, Bangkok 10310, Thailand, and marked "Sealed Proposal, A. D. R. P. Phase II".

The date for the opening of bids will be held at _____ o'clock p. m. / a. m., Thailand Standard Time on _____, 1990 at the JICA, Thailand Office.

A pre-bidding conference will be scheduled on _____, 1990 at _____ o'clock p. m. / a. m. at _____. Attendance for bidders is desirable.

_____

Resident Representative of JICA
Thailand Office

INSTRUCTION TO BIDDERS

IB-01 PREPARATION OF BIDS

All bids shall be submitted in an original and three (3) copies on or before the hour and date fixed for receipt of bids, in accordance with the Invitation for Bids, and shall conform to the following requirements ;

a) One copy of proposal shall be marked "original". The original and copies of bids shall be submitted in its entirety with all blanks in the proposal properly filled in.

b) Bids prices shall be written in words as well as in figures. In case of discrepancy between the words and figures, the price in words shall prevail.

c) The proposal must be signed by the Bidder with his usual signature and shall show his full business address.

IB-02 BASIS ON WHICH BIDS ARE REQUESTED

The form of the Contract to be awarded is on fixed unit Price basis of payment to the Contractor, as specifically set forth in these Contract Documents. Bids are requested on the above basis and a proposal which is on any other basis will not be considered.

Quotation of prices shall be made in Thai Baht and the Contractor shall be paid in Local Currency.

IB-03 BID SECURITY

The original, but not the copies of each bid, shall be accompanied by a proposal bond in an amount equivalent to ten(10) % of the total bid price in the form of cash or certified check, as a guarantee that the successful bidder will, within ten(10) days from receipt of the notice of award, enter into Contract with the Japan International Cooperation Agency, Thailand Office, and complete faithful performance of the work specified in these Contract Documents. In case the successful bidder fails for any reason to execute such

contract within the stipulated time, the bid security shall be forfeited to the Japan International Cooperation Agency, Thailand Office as liquidated damages.

The bid securities will be returned without interest after the successful bidder has signed the Contract.

IB-04 DELIVERY OF BIDS

Bids shall be directly delivered to the Japan International Cooperation Agency, Thailand Office, _____ _____ on or before the hour and date set for the opening of bids.

IB-05 WITHDRAWAL OF BIDS

A bidder will be allowed to withdraw his bid prior to the time set for the opening of bids if he communicates his purpose in writing to the Japan International Cooperation Agency, Thailand Office, and his bid shall be returned to him unopened. No bid can be withdrawn for any reason whatsoever after the opening of bids has been made.

IB-06 BIDDER'S RESPONSIBILITY

The bidders shall be responsible for having taken steps to carefully examine all of the Contract Documents and also to have fully informed themselves as to all conditions, locality and otherwise, affecting the carrying out of the Contract Works. Failure to do so will be at the Bidder's risk.

IB-07 DATA TO BE SUBMITTED WITH PROPOSAL

All proposal shall contain the following documents:

a) A construction schedule showing the detailed proposal plan of operation and construction of each main item in the Bill of Quantities from start to

completion of the Contract work. The schedule shall be in a bar chart form with weeks shown as the least unit of time and each main item on a separate horizontal line. The schedule shall also show expected monthly accomplishment and financial requirements based on the Bill of Quantities.

b) A list of equipment proposed to be used for the performance of the Contract Work. This list shall specifically enumerate the number, type and capacity.

IB-08 INTERPRETATION OF CONTRACT DOCUMENTS

If the prospective Bidder is in doubt as to the true meaning of any part of the Contract Documents, the Bidder may submit to the Japan International Cooperation Agency, Thailand Office, a written request for interpretation allowing sufficient time for a reply to reach him before submission of his bid. Any interpretation of the proposed documents will be made only by a Supplemental Notice duly issued.

IB-09 PRE-BIDDING CONFERENCE

A pre-bidding conference will be scheduled on_____ 1990 at _____ o'clock p.m./a.m. at_____. Attendance for Bidders is desirable.

IB-10 COMPARISON OF BIDS

In making its selection, the Japan International Cooperation Agency, Thailand Office will not be bound to award a Contract to the bidder submitting the Bid with the lowest indicated cost, but will take into consideration the bid prices, unbalanced bid, guaranteed completion time and other relevant consideration.

IB-11 AWARD OF CONTRACT

Bids will be opened in the presence of the Bidders who may desire to attend such opening by the Japan International Cooperation Agency, Thailand Office, at ____o'clock p.m./a.m. Thailand Standard Time on_____, 1990.

Promptly after the opening of the bids the Japan International Cooperation Agency, Thailand Office will undertake a detailed study and appraisal of the proposal submitted. The Contract will be awarded to the Bidder whose proposal is considered to be the most advantageous to the Japan International Cooperation Agency, Thailand Office. The Japan International Cooperation Agency, Thailand Office reserves the right to reject any and all bids received.

IB-12 BID DOCUMENTS

Bid documents shall include the following;

a) Invitation for Bids
b) Instruction to Bidders
c) Proposal
d) Pledge Agreement
e) Contract
f) Technical Specifications
g) Terms and conditions of this Contract
h) Bill of Quantities
i) Drawings

PROPOSAL

To : Mr.
The Resident Representative
Japan International Cooperation Agency, Thailand Office
1674/1, New Petchburi Road, Bangkok 10310

P-01 BILL OF QUANTITIES AND BID PRICES

The undersigned Bidder having carefully examined in their entirety the Contract Documents for the Construction Work of The Demonstration Farm on the Agricultural Development Research Project Phase II, hereby offers and proposes to perform all of the construction and services, to furnish all equipments, materials, supplies, labor and other items described in the Contract Documents, all for the unit or lump sum prices stated in words and figures in the following Quantities :

_____

Toral Price of Estimated Cost
(in words and figures)

- Bill of Quantities to be attached herein -

P-02 GUARANTEE OF COMPLETION

The undersigned Bidder guarantees to effect the commencement, prosecution and completion of the Contract Works.

P-03 BID SECURITY

The undersigned Bidder hereby certifies that all statements herein are made on behalf of _____;

Dated this _____ day of _____.

_____

Name _____

Title _____

Firm's Name _____

Firm's Address _____

Witness

_____

TERMS AND CONDITIONS OF THIS CONTRACT

Section 1 General Information

1.1 Objective

According to the Record of Discussion signed December 16, 1988, technical cooperation concerning Agricultural Development Research Project Phase II in North-East Thailand (hereinafter referred to as " the Project") will be carried out.

The objective of the Works are to construct the Demonstration Farm which will prove the fruits of the developed cropping technology based on technical cooperation.

1.2 Location of the site

The job site is located at Khao Suan Kwang, Khon Kaen, 40280.

1.3 Collaboration

According to the objective of the technical cooperation, the counterpart agency of the JICA is executing several experiments around the job site. Prior to or during the course of the Works, the Contractor shall make the good relation with the related Organizations *) for the satisfactory implementation of the Works as to secure full collaboration. Should it happen that the relation between these Organizations and the Contractor is disturbed, the Contractor shall inform the Inspection Committee who will conciliate the both parties.

*) A.D.R.C : Agricultural Development Research Center
DLD : Department of Land Development
DOA : Department of Agriculture
KKV : Khon Kaen University

Section 2 Submission of Notices

2.1 Work schedule

The Contractor shall submit the Work Schedule in following items before the commencement of the Works at the job site. If the Contractor intends to change the Work

schedule, the approval from the Inspection Committee shall be obtained prior to the modification of the schedule.

1. Preparation of facilities and transportation of equipment etc. to the job site
2. Reservoir
3. Drainage Canal
4. Farm Road
5. Irrigation Facilities
6. Run-off Plots
7. Finishing of Field
8. Building
9. Clearing of Site

Also the Contractor shall submit the machineries scheme including the numbers, kind of machineries and using period of them.

2.2 Notices

The JICA and the Contractor shall submit the notices to each other, as necessary, in accordance with Article 19 in this Contract within reasonable time except that special articles are provided in Terms and Conditions of this Contract.

Section 3 Field Test and Inspection

The field tests in accordance with the Technical Specification and the demands from the Inspection Committee shall be the responsibility for the Contractor. The charges for such field test shall be included in the total amount of the construction cost, and the Contractor is not entitled to claim any amount of the field test charges.

Section 4 Modification of Plan

In case the JICA estimate the cost for the modification in accordance with Article, and if there are two portions, one for the increase and the other for the decrease of the construction cost resulting from such modification, the JICA shall have the right to offset

them in the payment and pay of claim the diference between the increase and decrease of the construction cost as the case may be.

Section 5 Release from the Works

After the final acceptance of the Works by the JICA, the Contractor shall remove its own temporary facilities, warehouses, construction roads, electric wiring, surplus material, debris and so forth which were provided by the Contractor within ten (10) days. Upon approval of the Inspection Committee for the removal of the abovementioned facilities etc., the Contractor will be released from its responsibility of the Works but remains responsible under one (1) year guarantee of the Works as specified in Article 11 in this Contract.

Section 6 General Obligations of the Contractor

6.1 Temporary office and residence

In case the Contractor intends to build the temporary office, residence and so forth, the Contractor shall submit the plan to the Inspection Committee for approval at least ten (10) days in advance of the commencement of the Works.

The Contractor is required to always keep the buildings and facilities in good condition and to make proper drainage and sanitary system. Should the Contractor build them outside of the job site, the Contractor shall arrange with the owner of the such land and at its own expense.

6.2 Fuel storage

In area of temporary office and residence, the fuel tank capacity shall not exceed 1,000 liters and shall be far away from the housing area.

Fuel storage and transportation shall be done with care and shall have a good system of fire prevention. If storage licence is required, the Contractor shall arrange for obtaining it.

6.3 Other facilities

All necessary facilities for the Works and the Contractor's convenience shall be provided and maintained in good condition by the Contractor.

Section 7 General Text

The Contractor shall implement the Works in accordance with the Contract Documents in broad sense such as the Contract in narrow sense, Terms and Conditions of this Contract, Technical Specifications. Should the events occur that the both parties can not reach agreement on the interpretaion of the above-mentioned Contract Documents in broad sense, both parties shall negotiate with sincerity and good faith for settlement of any disagreement, failing with the decision of the JICA shall prevail.

PLEDGE AGREEMENT

To Japan International Cooperation Agency, Thailand Office
Date _____

We _____, the Contractor hereby agree that all equipment, materials and supplies brought to the job site under this Contract made with the JICA dated on _____, shall be pledged by us with the JICA as security for our execution of Works, and shall not be removed at any time without prior approval of the JICA in writting.

We further agree that should there be any loss or damage to pledged equipment, materials and supplies kept at the job site, the JICA shall bear no responsibility whatsoever for such loss or damage.

_____
Name _____
Title _____
Firm's Name _____
Firm's Address _____

CONTRACT

FOR

CONSTRUCTION WORK OF THE DEMONSTRATION FARM

ON

THE AGRICULTURAL DEVELOPMENT RESEARCH PROJECT

PHASE II

IN

NORTH-EAST THAILAND

JAPAN INTERNATIONAL COOPERATION AGENCY

THAILAND OFFICE

CONTRACT

CONSTRUCTION WORK OF THE DEMONSTRATION FARM ON THE AGRICULTURAL DEVELOPMENT PROJECT PHASE II IN NORTH-EAST THAILAND

This Contract is executed on the _____ day of _____ at the JICA Thailand Office between

The Japan International Cooperation Agency, Thailand Office, by _____, Title _____ as its authorized representative of the JICA Thailand Office, hereinafter referred to as "the JICA" of the one part, and

_____ whose office is situated at _____

Tel. _____ Represented by _____

Nationality _____ Title _____ hereinafter referred to as "the Contractor", of the other part.

Both parties mutually agree under the terms of this Contract as follows :-

Article 1 Purpose of Agreement and Contract Price

The JICA agrees to employ the Contractor and the Contractor agrees to perform the Works for the Construction of the Demonstration Farm on the Agricultural Development Research Project Phase II in North-East Thailand for the total amount of _____ _____ Baht (_____ Baht), hereinafter referred to as "Contract Price".

The following documents shall form integral part of this Contract :-

Terms and conditions of this contract
Pledge agreement
Technical specifications
Bill of Quantities
Drawings

Article 2 Performance Bond

As a security for the faithful performance of the Works under this Contract, the Contractor has on the execution of this Contract deposited a performation bond with the JICA in lieu thereof a Bank Guarantee issued by the The Bank of _____ bearing the number _____ and dated on _____ in the amount of _____ Baht (_____ Baht) which represents five (5) percent of the Contract Price, the name of the issuing bank and the form of the bank guarantee are to be approved by the JICA.

The JICA will return the Performance Bond in cash or the Bank Guarantee to the Contractor after final acceptance of the Works by the JICA as stipulated in Article 15 of this Contract, provided that the completed Works shall not show any defect or damage caused through the fault of the Contractor, or through the fault of any new Contractor in the case of termination of Contract by the JICA under Article 4.

Should the Contractor be in default, the JICA shall have the right to demand payment from all or any part of the Performance Bond. In addition, the Contractor shall remain liable for the full loss sustained by the JICA.

Article 3 Payment

The JICA agrees to effect payments for the Works to the Contractor in the following manner :-

a. Advance Payment, to be effected upon the bringing of part of equipment and materials required for the Works and having stored at the job site by the

Contractor, and upon the verification of those facts by the Inspection Committee.

_____ Baht (_____ Baht)

which corresponds to Thirty (30) percent of the Contract Price, shall be paid upon signing of this Contract.

b. Interim Payment, to be effected according to the progress of the Works satisfactorily executed by the Contractor and accepted by the Inspection Committee.

_____ Baht (_____ Baht)

which corresponds to Forty (40) percent of the Contract Price, shall be requested for payment at _____.

c. Final Payment, to be effected upon the satisfactory completion of the Works by the Contractor and accepted by the Inspection committee.

The remainder of _____ Baht (_____ Baht) which corresponds to Thirty (30) percent of the Contract Price, shall be paid after the Final Certificate by the JICA for payment to the Contractor.

Payment under (b) and (c) shall be effected within ten (10) days after the respective acceptance of the Works by the Inspection Committee.

Taxes payable by the Contractor, if any, shall be deducted at source by the JICA on each payment.

It is expressly understood that payments by the JICA do not mean acceptance responsibilities under this Contract.

Article 4 Completion Time

The Contractor agrees to commence the Works at the site within ten (10) days from the date of signing of this Contract (commencement date) and the Contractor agrees to satisfactorily complete the Works within _____ days (completion time) from the date hereof which will become due on _____ (completion date).

If the Contractor fails to commence the Works by the above commencement date, or should in the course of the construction any event occur which may reasonably cause the JICA to believe that the Contractor will not be able to complete the Works on the completion date, or should the Contractor fail to complete the Works by the completion date, or should the Contractor fail to meet any of the Contract requirement, the JICA shall have the right to terminate this Contract by giving written notice to the Contractor.

However, in case that the Contractor fails to complete the Works by the completion date, or to meet any of the Contract requirement, if the Inspection Committee thinks that the Contractor has the ability for completion of the Works within reasonably extended period, the Contractor may be permitted by the JICA to continue the Works beyond the completion date but within the extended time.

Article 5 Penalty

In case that the Contractor is in default as mentioned in Article 4, the Contractor agrees to be responsible to the JICA as follows :-

5.1 In case of the termination by the default of commencement for the Works, the Contractor shall pay a penalty of _____ Baht (_____ Baht) per day counting from the commencement date until the new Contract is completely executed with a new Contractor for this Works, the period of which is included the time spent for finding the new Contractor and executing the new Contract etc.

5.2 In case the JICA thinks that the Contractor will not be able to complete the Works within the completion time and thereby terminates this Contract, the Contractor shall pay a penalty of _____ Baht (_____ Baht) per day counting the number of days in the same manner as prescribed in 5.1 above. However, the JICA may reduce such number of days according to the ratio between the completed Works and the total Works as may be decided by the Inspection committee.

5.3 In case the Contractor fails to complete the Works by the completion date or to meet any Contract requirement, the Contractor shall pay a penalty of _____ Baht (_____ Baht) per day counting from the date following the completion date until the Works satisfactorily completed and accepted by the Inspection Committee.

Article 6 Compensation

If the JICA sustains any losses as direct or indirect damages caused by the Contractor's failure, the Contractor shall compensate the JICA for such losses. The parties agree that time is essential for the completion of the Works.

Article 7 The JICA's right for default

The JICA has the sole and absolute right to decide whether to terminate the Contract, to impose only the penalty on the Contractor or to claim the compensation for the damage as stated in Article 5 or Article 6. The money due to the JICA exercising its right under this article shall be retained and deducted from any money due to the Contractor but yet unpaid, including from the performance bond. If the total amount of the loss is larger than the money above-mentioned, the Contractor agrees that the JICA has the right to retain the construction equipment, materials and supplies etc. and demand payment of the balance from such equipment etc. or proceeds of sale thereof.

Article 8 Contractor's responsibility on termination of this Contract

After the contract has been terminated in accordance with the foregoing Article 4, the JICA shall have the right to employ another Contractor (hereinafter referred to as "New Contractor") to carry on the remaining parts of the Works, and the payment for the Contractor that fail to complete the work shall be made out of the necessary Contract price for the remaining Works. Should the remaining amount after payment of the advance and interim payment from the Contract price, be insufficient to effect payment to the new Contractor, the difference between such remaining amount and actual cost estimated by the JICA for the satisfactory completion Works carried out by the new Contractor, shall be deemed as direct loss sustained by the JICA, and the Contractor shall pay such difference to the JICA within ten (10) days from the date of request by the JICA, failing which interest at the rate of eighteen (18) percent per annum shall be charged thereon.

Article 9 Inspection Committee

The Inspection committee, authorized to act on behalf of the JICA will be appointed by the JICA and the Inspection Committee is entitled to do all things that the JICA may do so. The Inspection Committee shall control and supervise the Works all the times whether it is in the preparation or implementation of the Works and the Contractor shall promptly furnish all necessary facilities for proper inspections of the Works in accordance with the Inspection Committee's request. At any moment the Inspection Committee can request the Contractor to stop the Works, if necessary and the Contractor shall have no claim on the JICA for extension of the completion time due to such suspension of the Works under this Article.

The inspection will not be deemed as the acceptance of the Works, and the Contractor shall not be relieved from his responsibility to meet the Contract requirements by the fact that the Inspection Committee exercise their duties. Should it be found that the Works have not been satisfactorily performed in the faithful manner, the Contractor shall correct any part of the Works indicated by the Inspection Committee within the period specified by the Inspection Committee.

Article 10 Prohibition for the equipment removal

Should the Contractor fail to complete the Works during the completion time or the Inspection Committee thinks that the Contractor will not be able to satisfactorily complete the Works, any equipment and materials brought to the site for use on the Works shall not be removed without the prior approval of the Inspection Committee in writing.

Article 11 Rectification of the defective construction

For a further period of One (1) year after satisfactory completion and final acceptance of the Works by the JICA, whether completed by the Contractor or by the new Contractor in case of termination of Contract under Article 4, any damage to the Works which is caused by the Contractor's fault, either because of defective workmanship or the use of inferior materials or any other cause, shall be made good as necessary by the Contractor to the satisfaction of the JICA at no extra cost.

In case of the termination of the Contract, the JICA may decide which part of the Works should come under the Contractor's responsibility, and requests the Contractor to make good of the damaged Works. Should the Contractor fail to do so within period specified after receipt of written request to do so from the JICA, the JICA shall have the right to employ another Contractor to carry out such work and the Contractor agrees to bear all expenses incurred.

Article 12 Discrepancies among the Contract Documents

If, prior to or during the course of the Works, any discrepancies are found in the drawings and/or the Technical Specifications etc. attached to this Contract, the Contractor shall follow the ruling given by the Inspection Committee at no additional cost to the JICA.

Article 13 Construction Method and Temporary Works

The construction method including implementation schedule and plan of the temporary works such as installation of temporary facilities, offices, ware houses, construction road, electric wiring, etc. shall be submitted by the Contractor and approved by the Inspection Committee at least ten (10) days in advance of the commencement of the Works.

Should the cost of the above temporary works be estimated in the unit cost of each work items of Bill of Quantities in this Contract, the Contractor is not entitled to claim any amount of charges for the temporary works.

Article 14 Modification of Plant

If the Inspection Committee finds it necessary to make modification of construction design and/or materials and so forth during the course of construction, the JICA has the right to order the modification of the Works to the Contractor, and such order shall be made in writhing from the Inspection Committee to the Contractor.

The JICA agrees to adjust upwards or downwards the necessary expense for such modification to the Contractor, which will be estimated by unit price in the Bill of Quantities of this Contract in case of modification of quantities of construction works. In the case of additional works which are not quoted by unit price in the Bill of Quantities of this Contract, the Inspection Committee will make estimation thereof and the JICA will pay to the Contractor for such additional works accordingly. But if the Contractor does not agree to such estimation, the Contractor is then entitled to negotiate with the JICA. Also the extension of the completion time due to the modification shall be given by the JICA who shall have the sole right to decide the number of days of such extension.

Article 15 Acceptance of the Works

When the entire Works have been completed, the Contractor shall submit the invoice in written form indicating the Work actually completed to the Inspection Committee. If there are compliance with drawings or Technical Specifications, the JICA shall accept the Works as the final acceptance of satisfactory completion Works within ten (10) days after the receipt of the written form and it shall be deemed that the final acceptance has been made on such date of the receipt of the written form.

On the other hand, should non-compliance with drawings or Technical Specifications or defects be found in the Works executed by the Contractor, the Inspection Committee will have the right not to accept the Works and to order the rectification of the Works. If the required period for the rectification of the Works is beyond the completion date, the Contractor shall not be relieved from its responsibility to pay the penalty as stipulated under Clause 5.3, and after the completion of rectification of the Works, then the final acceptance will be made in the same manner as described in the first paragraph of this Article.

During the course of construction, whether in the completion time or of extended time specified in the last paragraph of Article 4, the JICA has the right to accept a part of the Works already completed in the written form which shall be considered as a part of final acceptance. However, both parties shall negotiate with each other for the maintenance and usage of the accepted part of the Works, and the Contractor is not entitled to request the extension of the completion time due to any interruption caused by the use of such accepted Works by the JICA, or any delay in repairing such accepted Works.

Article 16 Construction Engineer

The Contractor shall appoint a construction engineer at his own expense for the supervision of the Works performance, who shall be authorized to act on behalf of the Contractor, and the instructions given to him shall be deemed as given to the Contractor. Such construction engineer shall be a well English-speaking person and accepted by the JICA, who shall stay at the job site all the time and shall not leave without obtaining the prior approval of the Inspection Committee. If the Contractor replaces the construction engineer, the Contractor shall obtain the prior approval from the Inspection Committee in writing.

Article 17 Replacement of Labour, Engineer and Foreman

The Inspection Committee may request the Contractor to remove any of the Contractor's labours, foremen or engineers if it appears to the Inspection Committee that such labour, foreman or engineer is incompetent for his job or is not suitable or is not capable of handling his workmen or staff, and the Contractor shall promptly replace any such labour, foreman or engineer. No extra cost or claim for extension of time will be allowed because of such replacement.

Article 18 Sub-Contractor

The Contractor shall not sub-contract or assign any portion of the Works under this Contract without obtaining the prior approval of the JICA who has the sole right to decide which portion of the Works may be sub-contracted or assigned to the Sub-Contractor. However, the Contractor shall be fully responsible for the Works done by the Sub-Contractor.

Article 19 Notice

All notices required by this Contract shall be effective only at the time of receipt thereof, and only when received by the parties concerned at following address :-

The JICA Thailand Office
1674/1, New Petchburi Road, Bangkok 10310, Thailand

The Contractor _____
_____
_____

All Notices required by the terms of this Contract shall be made in writing in English Language, and delivered by registered mail or hand delivery.

Article 20 Dispute

In the event of any dispute arising from the interpretation and performance of the terms of this Contract, both parties agree to make the best attempt with sincerity and in good faith to negotiate and amicably settle such dispute, failing which the parties agree to refer such dispute to arbitration under Thai Commercial Arbitration Rules and Regulation, Bangkok, by 2 arbitrators, each of which is to be appointed by each party. If either party fails to appoint its arbitrator whithin seven (7) days or should the arbitrators fail, within fifteen (15) days after their appointment, to agree upon the decision of the dispute or no decision is reached on the appointment of an umpire, then the dispute shall be brought before the Court of Thailand for decision under the laws and procedures of the Kingdom of Thailand.

This Contract is executed in duplicate of the same tenor, one of the original copy to be kept by JICA and the other original copy to be kept by the Contractor. Both the JICA and the Contractor have set their signatures and affixed the seals thereto in the presence of the witnesses.

JICA

Mr. ,

Resident Representative,
Japan International Cooperation Agency, Thailand Office.

Contractor

Witness

Witness

TECHNICAL SPECIFICATIONS

ON

CONSTRUCTION WORK OF THE DEMONSTRATION FARM

FOR

THE AGRICULTURAL DEVELOPMENT RESEARCH PROJECT

PHASE II

IN

NORTHEAST THAILAND

JAPAN INTERNATIONAL COOPERATION AGENCY

THAILAND OFFICE