DESIGN REPORT

MAE KLONG PILOT PROJECT

IN

THE TECHNICAL CO-OPERATION PROJECT

ON

THE IRRIGATED AGRICULTURE DEVELOPMENT

IN

THAILAND

DECEMBER 1977

JAPAN INTERNATIONAL COOPERATION AGENCY

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FOREWORD

This report on the detailed design for the Mae Klong Pilot Project, an integral part of the Technical Cooperation Project on the Irrigated Agriculture Development in Thailand, was submitted by the Detailed Design Survey Team headed by Mr. Kunio Iki.

The Team was organized and dispatched to Thailand by the Japan International Cooperation Agency, for the purpose of preparing the detailed design of the Mae Klong Pilot Project under the above-mentioned Technical Cooperation Project which was commenced in accordance with the Record of Discussions concluded between both countries on April 8, 1977.

It is firmly believed that this report basing upon the close consultation with the Thai authorities concerned and the findings the Team attained will greatly contribute toward smooth and effective implementation of the Project.

Last but not the least, I wish to thank the Team for their efforts and cooperation. Acknowledgement is also made with gratitude for the guidance, in dispatching the survey team, accorded by the Ministry of Foreign Affairs and Ministry of Agriculture and Forestry and other personnel concerned, as well as to Thai officials whose wholehearted cooperation made the Team's work a success.

December 1977

MICHIO NAKAHARA
Director
Agricultural Development
Cooperation Department
Japan International Cooperation
Agency

Letter of Transmittal

Mr. Michio Nakahara
Director
Agricultural Development Cooperation Department
Japan International Cooperation Agency
Tokyo

Dear Sir,

I have the honour to submit herewith our report on the detailed designed for the Mae Klong Pilot Project which is one of the sub-projects established under the Technical Cooperation Project on the Irrigated Agriculture Development in Thailand in accordance with the Record of Discussions dated April 8, 1977. The team has carried out the detailed design survey for the period of twenty-five days from September 20 to October 14, 1977.

In the course of our field work, we have been encouraged in our survey with great expectation placed by the Thai authorities concerned, thereby, the team has been able to complete the survey within the given period, under the close cooperation of the Thai authorities concerned.

I hope that this report will be fully utilized as a guide and basic materials for successful realization of the Mae Klong Pilot Project. Furthermore, I hope that the Project will prove to be helpful to the development of agriculture in Thailand as well as to The Mae Klong Basin.

Finally, I take this opportunity to express my hearty thanks to the Thai authorities concerned, Embassy of Japan in Bangkok, Overseas Office of Japan International Cooperation Agency in Bangkok and Japanese Experts in Thailand for their valuable assistance and cooperation extended the team throughout the survey-period.

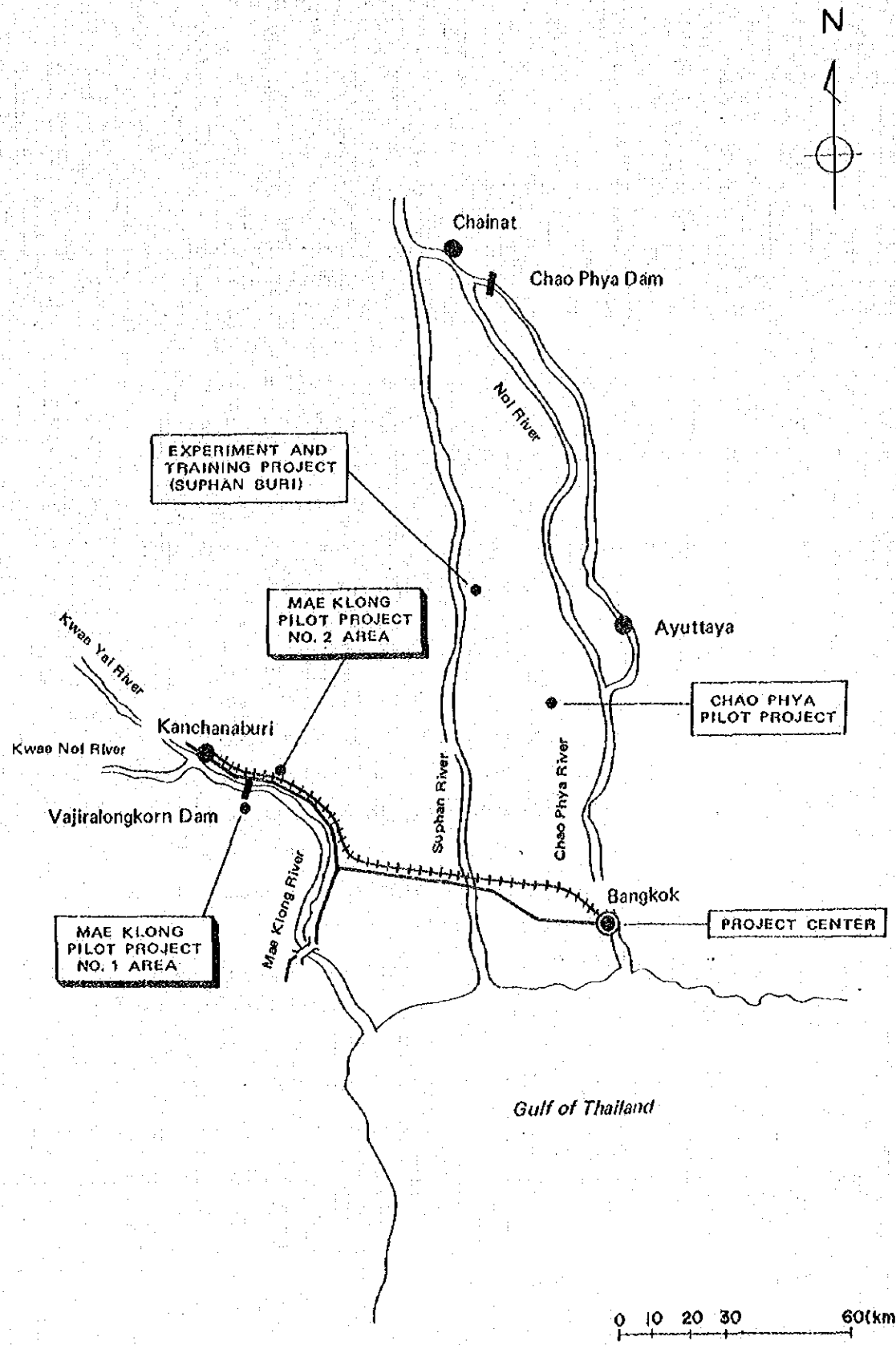
Very truly yours,

Kunio Iki

December 1977

Kunio Iki
Team Leader for the
Detailed Design Survey of the
Mae Klong Pilot Project, the
Technical Cooperation Project
on the Irrigated Agriculture
Development in Thailand

LOCATION MAP OF THE PROJECT



T A B L E O F C O N T E N T S

ABBREVIATION

mm	:	millimeter
cm	:	centimeter
m	:	meter
km	:	kilometer
sq.m, m^2	:	square meter
sq.km, km^2	:	square kilometer
rai	:	Thai unit of area, 1 rai = 0.16 ha
ha	:	hectare
l, lit	:	liter
cu.m, m^3	:	cubic meter
lit/sec	:	liter per second
cu.m/sec	:	cubic meter per second
lit/sec/ha	:	liter per second per hectare
PPM	:	part per million
ton, m.t	:	metric ton
El.	:	elevation above mean sea level
MSL	:	mean sea level
NWL	:	normal water level
FWL	:	full water level
HWL	:	high water level
WL	:	water level
sec.	:	second
min.	:	minute
hr.	:	hour
min.	:	minimum
max.	:	maximum
%	:	percent
No.	:	number
°C	:	degree centigrade
HP	:	horse power
ET	:	evapotranspiration
HYV	:	high yield rice variety
O & M	:	operation and maintenance
FY	:	fiscal year
MOAC	:	Ministry of Agriculture and Cooperatives
ALRO	:	Agricultural Land Reform Office
RID	:	Royal Irrigation Department
CLCO	:	Central Land Consolidation Office
BAAC	:	Bank for Agriculture and Agricultural Cooperatives
Cahangwat	:	province
Amphoe	:	district
Tambon	:	sub-district
Muban	:	village
Khlong	:	canal

CHAPTER 1. PREFACE

1-1. The Outline of Japanese Technical Cooperation Program for Irrigated Agriculture Development in Thailand

The Government has formulated the plan of on-farm development, particularly the land consolidation program as core of the plan, (so-called Irrigated Agriculture Development), and took necessary legal and institutional measures in enforcement of Land Consolidation Act (1974) and Agricultural Land Reform Act (1975) for smooth execution of the development program. The Government carried out the administrative reorganization that had transferred the Royal Irrigation Department to have belonged to the Ministry of Interior, into the Ministry of Agriculture and Cooperatives, and newly established the Central Land Consolidation Office in charge of planning and execution of land consolidation projects, and the Agricultural Land Reform Office for promotion of the land reform.

In parallel with those positive measures for irrigated agriculture development, in February 1976, the Government of Thailand requested the Government of Japan to supply the technical cooperation in implementation of the land consolidation program.

In response to the request by the Government of Thailand, the Government of Japan dispatched the Preliminary Survey Mission on Irrigated Agriculture Project in Thailand (headed by Dr. T. Kimura) for 25-day assignment period to conduct the field survey and consultation with the Thai Government concerned. These series of activities resulted in enabling the Mission to have full understanding on the purpose and significance of the Project, and come to express keen interest therein. At the same time, it was confirmed that the Project would be materialized under the close cooperation of both countries and the Project Area would be limited to the Greater Mae Klong Basin and the Lower Greater Chao Phya Basin. The Scope of cooperation works were also defined for the Greater Mae Klong Basin, to planning and

implementation for establishing two pilot farms and conducting feasibility study for on-farm development with land consolidation and master plan formulation for the total Basin, and for the Greater Chao Phya Lower Basin, to conducting the feasibility study of the West Bank Tract, planning and implementation for establishing two pilot farms.

Along with the fundamental direction of the Preliminary Study Mission determined, the Government of Japan dispatched the Feasibility Study Mission (headed by Mr. S. Watanabe), on the irrigated agriculture development project in the West Bank Tract of the Lower Greater Chao Phya for two-month study started from October 1976, covering about 12,000 hectares in that basin.

In the mid-July 1977, the 47-day Survey Mission (led by Mr. J. Sakurai) was dispatched for conducting preliminary survey on the Master Plan Study of the Greater Mae Klong River Basin Irrigated Agriculture Development Project, and made field survey and exchange of views with the Thai Government Officials concerned about the approach to the Master Plan Study.

At the end of November 1976, the 15-day preparatory works were assigned to the Mission (led by Mr. Y. Ohata) to make frameworks for the following detailed survey, and the discussion meeting was held to formulate the plan of approach to the final design of the Pilot Farm Program.

And February through April 1977, the Detailed Survey Mission (headed by Mr. M. Nakahara) carried out the final plan formulation and detailed design for the pilot farms of the Greater Chao Phya and the Greater Mae Klong, and at the same time, the Mission had deliberate consultation with the Thai Government concerned on the implementation of the Pilot program and concluded to agree to the Record of Discussions concerning technical cooperation for the irrigated agriculture development in Thailand.

Following the Mission in the mid-September, the Final Design Mission was dispatched to conduct the 25-day survey works of two pilot areas in the Mae Klong Basin in accordance with the ready-prepared strategy by the above-mentioned mission.

1-2. Outline of Technical Cooperation

On April 8, 1977, agreement was concluded between both countries with the Record of Discussion, and the Project plan based on the said agreement was outlined as follows:

The Project aims at, under the close cooperation of both countries, promoting the land consolidation works that will enable to increase in rice production by yield increase per unit acreage and expansion of acreage for paddy double cropping, and contributing to improvement and diffusion of farming techniques together with farmers' organizations.

The Project consists of the Project Center and three sub-projects, namely Chao Phya Pilot Project, Mae Klong Pilot Project, and Experiment and Training Project, expediting the Irrigated Agriculture Development Plan integrally and effectively.

i) The Project Center

The Project Center will be established in Bangkok as the headquarter, and function as below.

(1) To give necessary technical advices for planning and implementation of the Irrigated Agriculture Development Plan in the Lower Greater Chao Phya Basin and the Greater Mae Klong Basin;

(2) To conduct managerial and coordinating works in order to promote smooth and effective implementation of three sub-projects.

ii) The Chao Phya Pilot Project

The Chao Phya Pilot Project of about 500 ha will be set up for agricultural development of the flood irrigation area in Tambol Phraya Banlu, Amphoe Lat Bua Luang, Changwat Ayutthaya.

iii) The Mae Klong Pilot Project

The Mae Klong Pilot Project (No. 1) of about 400 ha and the Mae Klong Pilot Project (No. 2) of about 500 ha will be set up in Tambol Maungchum and Banmai, Amphoe Tha Muang, Changwat Kanchanaburi and in Tambol Taklamen, Amphoe Tha Maka, Changwat Kanchanaburi respectively for agricultural development by means of multi-cropping.

As for the implementation of land consolidation works, the Mae Klong No. 1 area will be of intensive method and extensive method for the Mae Klong No. 2 area.

iv) Experiment and Training Project

The activities of the Suphan Buri Station located in Thambol Rua Yai, Amphoe Muang, Changwat Suphan Buri are as follows:

To conduct experiments and training on improved agricultural techniques for the successful implementation of the Irrigated Agriculture Development in the pilot areas and their vicinities. The experiment mentioned above will be primarily carried out by the Government of Thailand and the trainees will be agriculture officers and staff concerned.

The Japanese Cooperation to be given in the Project is detailed as follows:

(1) Dispatching the experts: The experts will be dispatched to the Project Center in Bangkok and other three sub-projects, including such long-term assigned staff as Team Leader, Irrigation & Drainage Engineers, Land Consolidation Engineers,

Agro-economists, Agronomists, Liaison Officer, etc., but not exceeding 20 members in total.

(2) Machineries, equipment, and agri-chemicals to be granted: The Government of Japan will grant the construction machineries for land consolidation works, farming machines, fertilizers, agri-chemicals and vehicles to be required for the Project execution.

(3) Training and study in Japan: The Thai counterparts personnel assigned to the Project will be trained in Japan to master techniques of irrigation & drainage, paddy cropping, etc. to be necessitated in the Project implementation.

The period of time for this Technical Cooperation is stated as five years.

1-3. Outline of Surveying for Final Design of the Mae Klong Pilot Projects

1-3-1. Purpose and Items of Surveying

On the basis of the Technical Cooperation Program for Irrigated Agriculture Development in Thailand (Prepared in July 1977), this survey has been made aiming at final design for consolidation of agricultural infrastructures including irrigation/drainage facilities, on-farm development, etc. of No. 1 (about 400 ha) and No. 2(about 500 ha) Pilot Projects, and at planning for improvement of farm management and agricultural organizations in the Project Area and its environs.

The following are the major works that have been carried out by the Mission:

1) Field surveys

- Field tests on soil and water rate
- Survey on farming
- Data collection
- Discussion with the Thai authorities concerned

2) Study items

i) Plan for consolidation of agricultural infrastructures

- Irrigation and drainage
- Land consolidation
- Water management

ii) Plan for farm management

- Land use
- Cropping pattern
- Agricultural production

iii) Agricultural supporting services

- Trial farm
- Model farm
- Farmers' organization

iv) Farm budget analysis of the benefited farmer

v) Architecture for trial farm

vi) Cost estimate

1-3-2. Working Record

The survey team for the Mae Klong Pilot Project carried out the field survey for the 25-day period from 20th September to 14th October 1977. The working records are summarized in TABLE 1-1.

1-3-3. Personnel Organization of the Survey Team

The personnel organization of the survey team is listed in TABLE 1-2.

TABLE 1-1. Working Record

Date	Day	Description
Sept. 20	Tues.	Arrival in Bangkok. Discussion on survey schedule with Project Center.
21	Wed.	Courtesy call to Japanese Embassy and JICA Bangkok Office.
22	Thurs.	First Joint Meeting with Thai authorities concerned (explanation of the purposes and schedule of the survey, request to the Thai Government for facilities for the survey). Data collection.
23	Fri.	Courtesy call to the Ministry of Agriculture and Cooperative, ALRO and CLCO. Data collection.
24	Sat.	Arrangement for field trips.
25	Sun.	Arrangement for field trips.
26	Mon.	Field trips to the Project Area with the staff of the Project Center. Field surveys (preliminary survey to the No. 1 and No. 2 Areas).
27	Tues.	Field surveys in the No. 1 Area. Discussion with the Mae Klong Irrigation Project Office. Data collection of agricultural statistics.
28	Wed.	Planning for the No. 2 Pilot Project and field surveys (Messrs. Iki, Kumata & Watanabe). Soil and water rate tests in the No. 1 Area (Messrs. Ohta, Matsubara & Takano).
29	Thurs.	Inspection trip to Ban Chao Nen Dam (Messrs. Iki, Kumata & Ohta). Soil and water rate tests in the No. 2 Area (Messrs. Matsubara & Takano). Survey coordination (Mr. Watanabe).
30	Fri.	Discussion on project planning with the Mae Klong Irrigation Project Office. Return to Bangkok.
Oct. 1	Sat.	Team meeting (findings of the field survey and schedule of succeeding survey).
2	Sun.	Holiday.
3	Mon.	Meeting with JICA Bangkok Office (explanation of the field trips and survey schedule by Messrs. Iki & Watanabe). Meeting with RID (Messrs. Kumata & Matsubara). Data collection (Messrs. Ohta & Takano).
4	Tues.	Visit to MOAC & ALRO (Messrs. Iki, Kumata & Watanabe). Team meeting.
5	Wed.	Meeting and discussion with the Project Center (finding of the field survey, approach to the project and contents of interim reports).

Table 1-1 (cont'd.)

Date	Day	Description
Oct. 6	Thurs.	Inspection trip to land consolidation project job sites (Messrs. Iki, Kumata & Watanabe). Data collection and arrangement (Messrs. Ohta, Matsubara & Takano).
7	Fri.	Inspection trip to land consolidation project job sites (Messrs. Iki, Kumata & Watanabe). Report writing (Messrs. Ohta, Matsubara & Takano).
8	Sat.	Team meeting (scope of the No. 2 Project, contents of interim reports).
9	Sun.	Report writing.
10	Mon.	Report writing and meeting with the Project Center.
11	Tues.	Report compilation.
12	Wed.	Second Joint Meeting with Thai authorities concerned (explanation of interim reports).
13	Thurs.	Report of the performance of surveys to Japanese Embassy and JICA Bangkok Office. Discussion on detailed design of the Project with the Mae Klong Irrigation Project Office.
14	Fri.	Return to Japan.

TABLE 1-2. Member List of the Team

Speciality	Name	Position
Team Leader	Mr. Kunio IKI	Director, Hitotsusegawa Irrigation Construction Branch Office, Kyushu Regional Agricultural Administration Bureau, Ministry of Agriculture and Forestry
Land Consolidation	Mr. Toshiro KUMATA	Senior Official, Agricultural Land Department, Niigata Prefecture Government
Irrigation & Drainage	Mr. Kunio OHTA	Consulting Engineer, Sanyu Consultants Inc.
Land Consolidation	Mr. Yasuo MATSUBARA	Consulting Engineer, Sanyu Consultants Inc.
Agronomy	Dr. Toshiro TAKANAO	Consulting Engineer, Sanyu Consultants Inc.
Coordination	Mr. Mitsuaki WATANABE	Staff, Agricultural Development Division, Agricultural Development Cooperation Department, Japan International Cooperation Agency

CHAPTER 2. PRESENT SITUATION

2-1. General

2-1-1. Location and Area

This Project area is composed of the Mae Klong No. 1 Pilot Project (hereinafter referred to as the No. 1 Pilot Project) and the Mae Klong No. 2 Pilot Project (hereinafter referred to as the No. 2 Pilot Project). The both project areas are located in the benefited area of the Greater Mae Klong Project, 120 km west of Bangkok. The Project area is connected with Bangkok by railway and national highway. It takes about some two hours to Bangkok through the national highway. The project area has high economic potentiality as a hinterland of Bangkok, the largest consuming city in the country. The proposed acreages of both Projects are 402 ha. for the No. 1 Pilot Project and 563 ha. for the No. 2 Pilot Project respectively.

The No. 1 Pilot Project is in Tha Maka irrigation area and the No. 2 Pilot Project in Kampeng Saen irrigation area of the Greater Mae Klong Project. The No. 1 area belongs administratively to Tambol Maungchum and Tambol Banmai, Amphoe Tha Muanag in Changwat Kanchanaburi, and the No. 2 area to Tambol Taklamen, Amphoe Tha Maka in Changwat Kanchanaburi.

2-1-2. Socio-Economy

Most of the inhabitants except very few merchants and laborers, in the Project Area and its immediate vicinity have been engaged in agriculture, all of them are Buddhist and several buddhism temples can be seen everywhere in the Area. The electric power supply is available in only the town districts and residential districts along the trunk roads, but no other public services such as water supply and telephone. The inhabitants use the rain water or the artesian well for their potable water and other domestic water use.

The survey made by Economic Section of Project Planning Division, RID, revealed that the percentage of part-owner farmers is very high as compared with that of national average as shown below.

Land Tenure (%)

Item	Project Area	National Average
Owner farmers	20	62
Part-owner farmers	67	32
Tenant farmers	13	6

The survey also shows that an average family consists of about 6.9 persons and cultivates 28.6 rai (4.6 ha). One family breed the domestic animals, 1.3 water buffalos, 1.7 cattles, 0.7 swines, 16 chickens, and 10 ducks on an average. Also, one farm household possesses generally 0.13 units of power-tillers, 0.2 units of shoulder-type sprayers, and 0.4 units of lift-up pumps on an average.

2-1-3. Agricultural Extension Services

The extension office of Changwat Kanchanaburi provides five extension officers and its sub-organization, the Amphoe extension office in Tha Muang, provides six extension staff consisting of a manager, a deputy manager, a clerk and three extension agents. These three agents are responsible for extension for paddy cropping and fruit-tree plantation, upland cropping and pest control, and vegetables cropping, respectively. Their service area, including 13 Tambol in the Amphoe, is too wide to cover with sufficient services by only three agents.

The Department of Agricultural Extension has formulated a national level program, in which the following targets are provided for the services in the Changwat Kanchanaburi:

1) Extension for paddy cropping;
2) Extension of cash crops;

3) Pest control;
4) Establishment of farming groups (aiming to promote extension of improved farming techniques and related matters).

For successful implementation of the above, the demonstration farms are planned to be provided together with distribution of informative pamphlets, home-visit services, and study on the farming in the advanced areas in the country.

The following works have been executed in 1977:

- Experimental growing of mushroom in the Kasesert University.
- Test application of agri-chemicals in Nakhon Sawan.
- Giving lectures in the Changwat Office.
- Training on farm management.
- Training on pest control.
- Training on fertilization.
- Training on second cropping.

However, every well-prepared program has not been successfully undertaken due to insufficient number of staff, much idle time in clerical, managerial works and difficulty in communication.

2-1-4. Farmers' Groups

The Rice Farmers' Groups have been already organized in two Muban in the proposed Pilot Project Area. The said groups have been provided for easening to give credit to farmers by the Bank for Agriculture and Agricultural Cooperatives (BAAC). The bank has loaned to farmers for their paddy cropping.

There are two agricultural cooperatives in Amphoe Tha Muang; one is the Tha Muang Agricultural Cooperative and another the Suwanaphum Agricultural Cooperative. They provide 17 and 15 branches, respectively and main service, though not so active, is to give credit to farmers.

2-1-5. Marketing and Crediting

The Project area and its immediate vicinity link with Bangok by National Highways, railways and navigation by canals and rivers in the downstream area. Most of the farm products have been transported to Bangkok through the above channels. Distribution of paddy exclusively depends upon the middle-men and the rice milling managements who are handling the paddy from purchase, transport to marketing. The rice mill have employed trucks exclusively for paddy transport.

The farmers have made contracts with quartermen for their sugar cane growing. The quartermen provide the farmers with productive inputs at two-percent interest per month, and purchase the sugar canes in the dry season, November through following April, to sell the products to factories. The quartermen hold a number of trucks as a means of transportation of the products, playing an important role in the sugar industry.

The BAAC basis credit has been given to individual farmers at 12-percent annual interest through the agricultural cooperatives and other farmers' groups in operation of bank's branch offices located in every Amphoe. On top of the above, the ordinary commercial banks, rice mill factories and money lenders have given loans to the farmers at annual interest ranging 12 to 20 percent.

2-2. Natural Conditions

2-2-1. Meteorology and Hydrology

a) Meteorology

The Project Area has tropical savanna climate providing two seasons, the wet season from May to October and the dry season from November to April. According to the records at the Kanchanaburi station, the monthly mean temperature is max. 31.4°C in April and min. 24.8°C in December, presenting the monthly temperature range of 6.6°C only (TABLE 2-1).

b) Hydrology

Rainfall. The annual mean rainfall of the Project area is 1,085 mm, 84% of which, that is 914 mm, falls in the wet season of six months. The rainfall of the dry season occupies only 16% of the annual rainfall. FIGURE 2-1 shows the location of several rainfall stations, and the rainfall of following six stations closely located to the Project Areas has been analyzed.

Name of Station

Kanchanaburi*
Tha Muang
Tha Maka*
Tha Pha Regulator*
Ban Pong*
Chom Bung

* indicates the stations the data of which are analyzed.

The annual mean rainfalls at Tha Muang and Chom Bung, as shown in TABLE 2-2, have considerably large differences from those at other four stations. The data of these two stations have been omitted from subjects of analysis, accordingly.

Monthly Mean Rainfall

Monthly Mean Rainfall (mm)

J	F	M	A	M	J	J	A	S	O	N	D	Annual Rainfall	Wet Season Period May-Oct.
8	11	30	61	145	98	112	127	222	210	55	6	1,085 mm	914 mm

NOTE: Mean value of 4 stations for 23 years, 1952-1974.

Annual Mean Rainfall

Return Period	Probable Annual Rainfall (mm)
normal year	1,085
3 years	949
5 years	867
10 years	786
15 years	749

NOTE: Mean value of 4 stations for 23 years, 1952-1974.

Consecutive Rainfall

Return Period	Maximum 1-day Rainfall (mm)	Maximum 2-day Rainfall (mm)	Maximum 3-day Rainfall (mm)
2 years	89	112	132
5 years	120	151	179
10 years	141	177	209
15 years	153	192	226

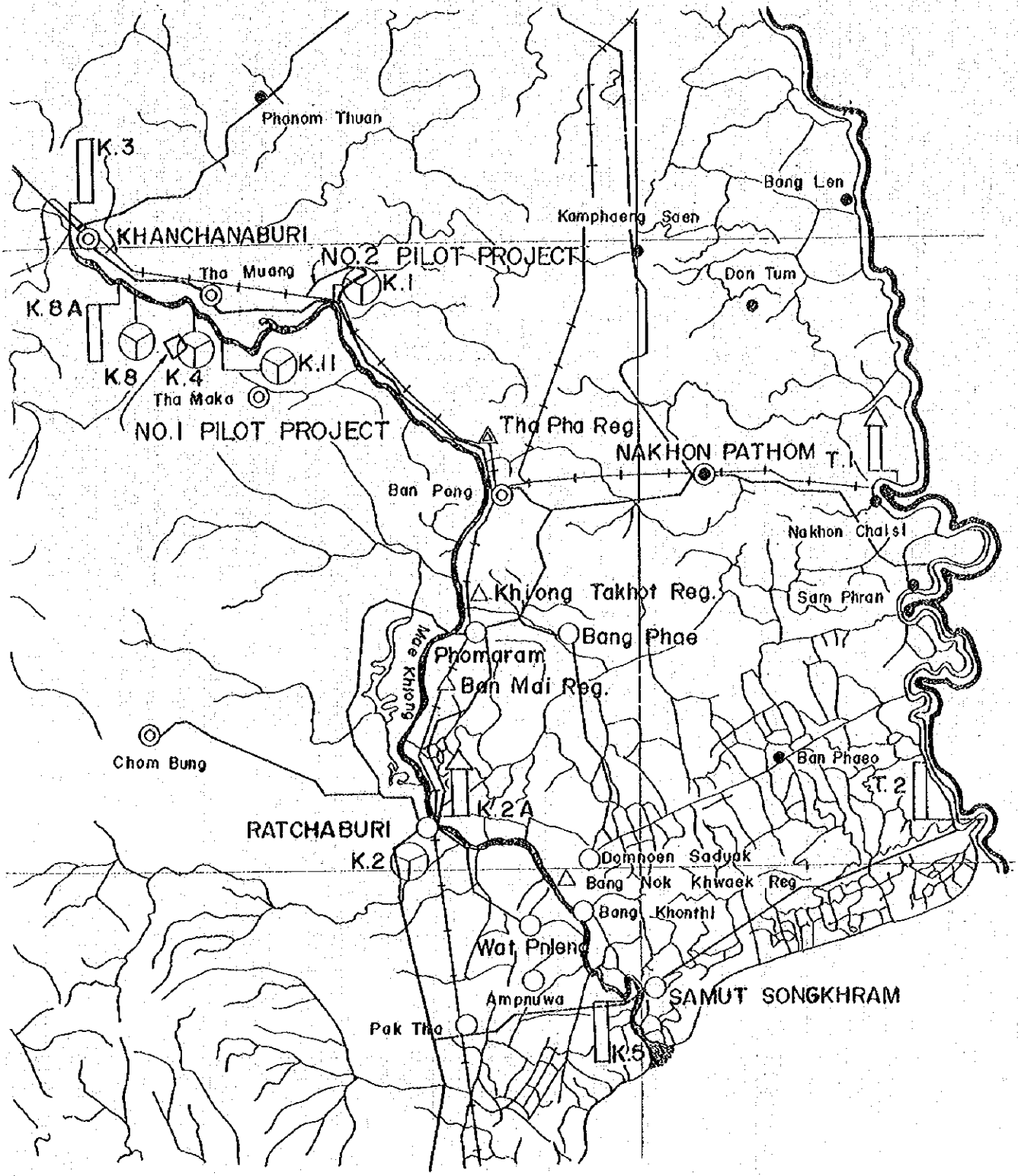
NOTE: Station, Kanchanaburi

Runoff. The rainfall in the wet season and the Mae Klong river are the water resources of the whole area of the Greater Mae Klong Project including this pilot project.

FIGURE 2-2 shows the monthly mean discharge of the Mae Klong river and its two big tributaries, the Kwae Yai and the Kwae Noi, the discharges of which fluctuate sharply in the wet and the dry seasons as well as the rainfall does.

The discharge of the Mae Klong is a little less than 100 cu.m/s in a period from January to May and becomes 50 cu.m/s, the minimum, in April. Under such conditions, it is difficult to secure the sufficient water to crop the dry season paddy. However, the Ban Chao Nen Dam would have constructed on the Kwae Yai river in 1977, starting

FIGURE 2-1 LOCATION OF RAINFALL STATIONS



Note; ○△ Rainfall Station
◎▲ Analysed Station

TABLE 2-1. Meteorological Data in the Vicinity of Project Areas

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual Mean
Monthly Mean Temperature (°C) 25 years (1951 - 1975)													
Suphanburi	26.1	28.5	30.5	31.8	30.7	29.9	29.2	28.9	28.4	28.0	27.0	25.6	28.7
Kanchanaburi	25.5	28.1	30.2	31.4	29.9	28.7	28.2	28.1	27.9	27.1	26.1	24.8	28.0
Monthly Relative Humidity (%) 22 years (1951 - 1972)													
Suphanburi	63.7	64.2	61.4	62.1	68.3	70.0	72.7	74.8	79.5	79.6	74.5	68.3	69.9
Kanchanaburi	62.5	60.7	57.5	60.0	70.2	72.8	73.9	74.3	77.6	79.9	74.6	67.4	69.1
Monthly Mean Wind Velocity (m/sec) 20 years (1951 - 1970)													
Suphanburi	3.1	3.2	3.7	3.9	3.7	4.0	4.1	3.8	3.4	3.4	3.7	3.4	3.6
Kanchanaburi	1.7	2.0	2.2	2.4	2.3	2.4	2.3	2.6	2.0	1.7	1.8	2.1	2.1
Daily Sunshine Hours (hours/day) 22 years (1951 - 1972)													
Bangkok	8.9	8.8	8.6	8.5	7.3	6.3	5.4	5.4	5.3	6.8	8.2	8.5	7.3

Source: Meteorological Department
Note : Location of Meteorological Stations

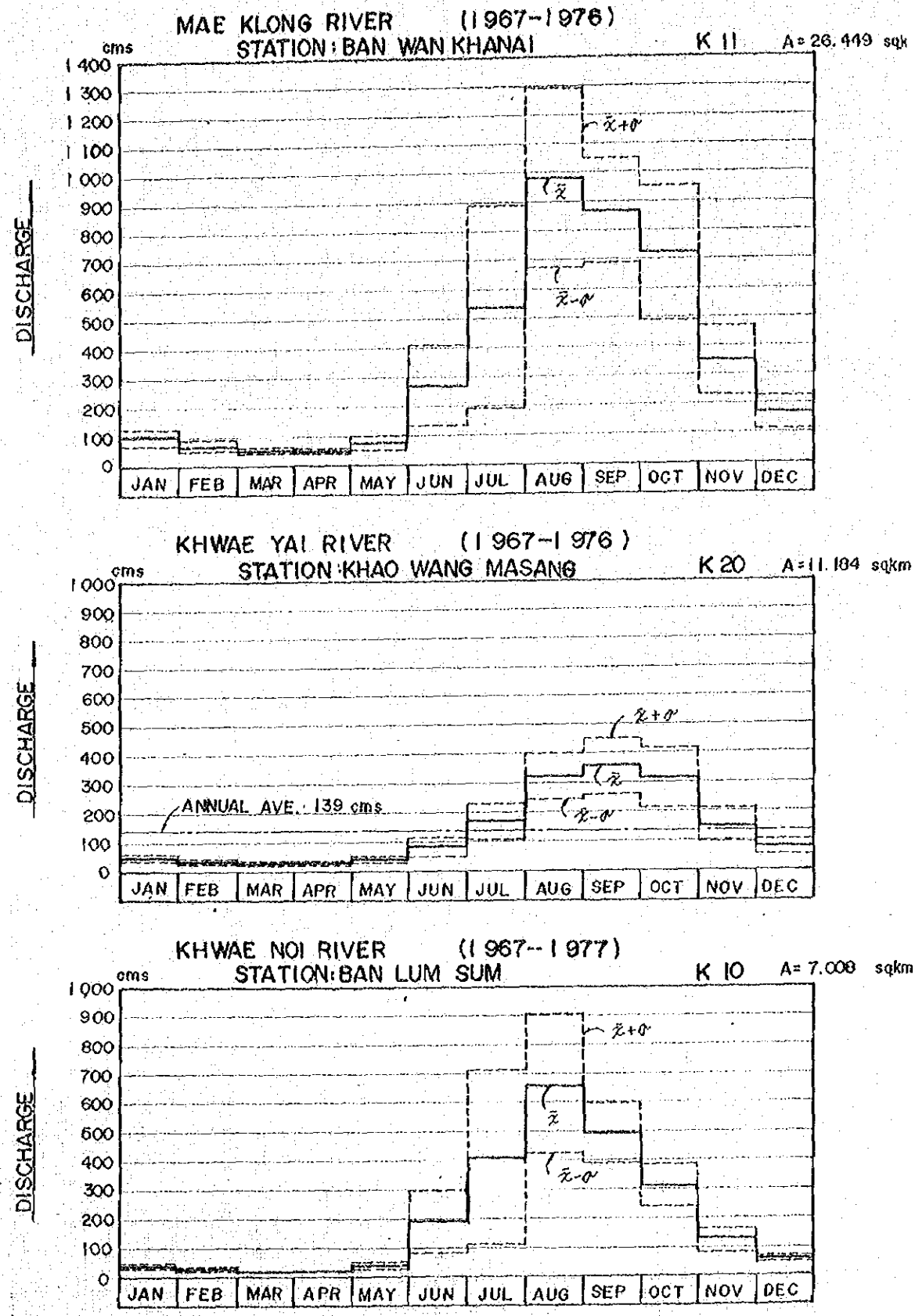
	Suphanburi	Kanchanaburi
Latitude	14°30'N	14°01'N
Longitude	100°10'E	99°32'E
Height of wind vane above ground	11.40 meters	15.80 meters

TABLE 2-2. Monthly Mean Rainfall and its Fulactuation (unit: mm)

Station		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual Total
Kanchanaburi	$\bar{x}$	5.5	10.1	34.7	78.3	148.3	88.7	102.9	107.4	241.9	217.0	62.4	9.0	1,106.2
	σ	16.3	20.9	45.7	44.3	64.2	38.4	44.7	52.4	110.1	97.2	52.7	18.3	
	$\bar{x}+\sigma$	21.8	31.0	80.4	122.6	212.5	127.1	147.6	159.8	352.0	314.2	115.4	27.3	
	$\bar{x}-\sigma$	-10.8	-10.8	-11.0	34.0	84.1	50.3	58.2	52.0	131.8	119.8	9.7	-9.3	
Tha Muang	$\bar{x}$	6.0	5.2	13.1	89.1	161.1	70.7	85.3	121.8	202.0	198.4	42.8	4.1	969.6
	σ	19.1	12.9	16.9	63.3	58.6	38.8	64.7	93.6	100.6	100.3	44.7	9.1	
	$\bar{x}+\sigma$	25.1	18.1	30.0	152.4	189.7	109.5	150.0	215.4	302.6	298.7	87.5	13.2	
	$\bar{x}-\sigma$	-13.1	-7.7	-3.8	25.8	72.5	31.9	20.6	28.2	101.4	98.1	-1.9	-5.0	
Tha Maka	$\bar{x}$	0.8	7.8	47.5	70.1	128.2	88.2	109.7	108.1	224.9	184.6	38.0	2.2	1,009.6
	σ	2.8	16.7	35.8	42.7	67.9	42.7	63.8	62.9	71.0	102.8	41.8	6.9	
	$\bar{x}+\sigma$	3.6	24.0	83.3	112.8	196.1	130.9	173.5	171.0	295.9	287.4	79.8	9.1	
	$\bar{x}-\sigma$	-2.0	-9.4	11.7	27.4	60.3	45.5	45.9	45.2	153.9	81.8	-3.8	-4.7	
Tha Pha Regulator	$\bar{x}$	6.3	15.1	19.2	43.4	150.8	105.6	119.4	144.8	212.3	220.3	59.0	6.3	1,102.5
	σ	16.4	12.8	28.7	47.4	111.2	46.3	65.0	70.7	95.0	107.9	48.8	11.4	
	$\bar{x}+\sigma$	22.7	27.9	47.9	90.8	262.0	153.9	184.4	215.5	307.3	328.2	107.8	17.7	
	$\bar{x}-\sigma$	-10.1	2.3	-9.5	-4.0	39.6	57.3	54.4	74.1	117.3	112.4	10.2	-5.1	
Ban Pong	$\bar{x}$	18.0	10.4	14.6	53.2	150.6	110.8	116.8	149.3	207.8	219.3	61.1	6.7	1,118.4
	σ	12.2	20.7	26.2	40.9	83.8	61.9	52.5	70.6	79.4	110.2	54.3	12.9	
	$\bar{x}+\sigma$	30.2	31.1	40.7	94.1	234.3	172.7	169.3	219.9	287.2	329.5	115.4	19.6	
	$\bar{x}-\sigma$	5.8	-10.3	-11.7	12.3	66.7	48.9	64.3	78.7	128.4	109.1	6.8	-6.2	
Chom Bung	$\bar{x}$	1.3	13.0	20.7	71.8	147.8	107.2	145.7	161.1	267.1	251.8	92.0	9.5	1,289.0
	σ	6.0	22.8	36.7	85.7	123.1	84.2	113.6	115.1	159.3	182.2	105.6	23.3	
	$\bar{x}+\sigma$	7.3	35.8	57.4	157.5	270.9	191.4	259.3	276.2	426.4	434.0	197.6	32.8	
	$\bar{x}-\sigma$	-4.7	-9.8	-16.0	-13.9	24.7	23.0	32.1	46.0	107.8	69.6	-13.6	-13.8	

Note: $\bar{x}$; Monthly Mean Rainfall (mm)
σ; Standard Deviation (mm)
Source: Hydrology Divison, RID

FIGURE 2-2 MONTHLY MEAN DISCHARGE (unit : cms)



NOte: $\bar{x}$ Monthly Mean Discharge (cms)
σ Standard Deviation (cms)

Source: Hydrology Division, RID

power generation from 1979. Therefore, it is expected that the discharge of the Mae Klong river in the dry season will be increased to the considerable extent.

Dimensions of Ban Chao Nen Dam

River: Kwae Yai River
Annual mean runoff: 4,400 MCM (Mean value in 1968-1976)
Total storage capacity: 17,700 MCM
Effective storage capacity: 7,500 MCM
Reservoir surface area: 419 sq. km.
Catchment area: 10,880 sq. km.

2-2-2. Topography and Soil

a) Topography

The topographic conditions of the Pilot Areas are summarized as follows:

	No. 1 Pilot Project Area	No. 2 Pilot Project Area
Project Area	402 ha.	563 ha.
Elevation (MSL)		
Maximum	EL 20.75	EL 15.00
Minimum	EL 19.50	EL 11.00
Difference	1.25 m	4.00 m
Gradient	1/1,000-1/5,000	1/1,000-1/5,000

The No. 1 Pilot Project Area forms nearly square shape with about 2 km side, with three sides bounded by IL-IR canal, road and main drainage canal, respectively.

The No. 2 Pilot Project Area is bounded north and west by Tha Sarn drainage canal, south by Left Main Canal, and east by Tha Sarn Bang Pla 10 RD, and the 3L canal runs through the Area, which forms strip shape with about 0.8 km width and about 7 km length.

b) Soil

i) Physical properties of soil

The soils of both No. 1 and No. 2 Pilot Project Areas contain silt contents by 60 percent, which are classified into clayey silt or sandy silt, and partly clayey soil with clay contents by 40 percent has been observed.

These properties are quite different from those of the Chao Phya Pilot Area that provides the soil classified into pure clay with 60-80 percent clayey contents.

Mechanical properties

The soils in the Project Areas have such mechanical properties as the angel of internal friction (ϕ) by 10 degress, the cohesion (c) by 0.4 kg/cm^2, the specific gravity by 2.62, and apparent specific gravity by 1.54.

Percolation rate

The percolation test on the soils of paddy fields revealed that the percolation rate was approximately 1 mm/day.

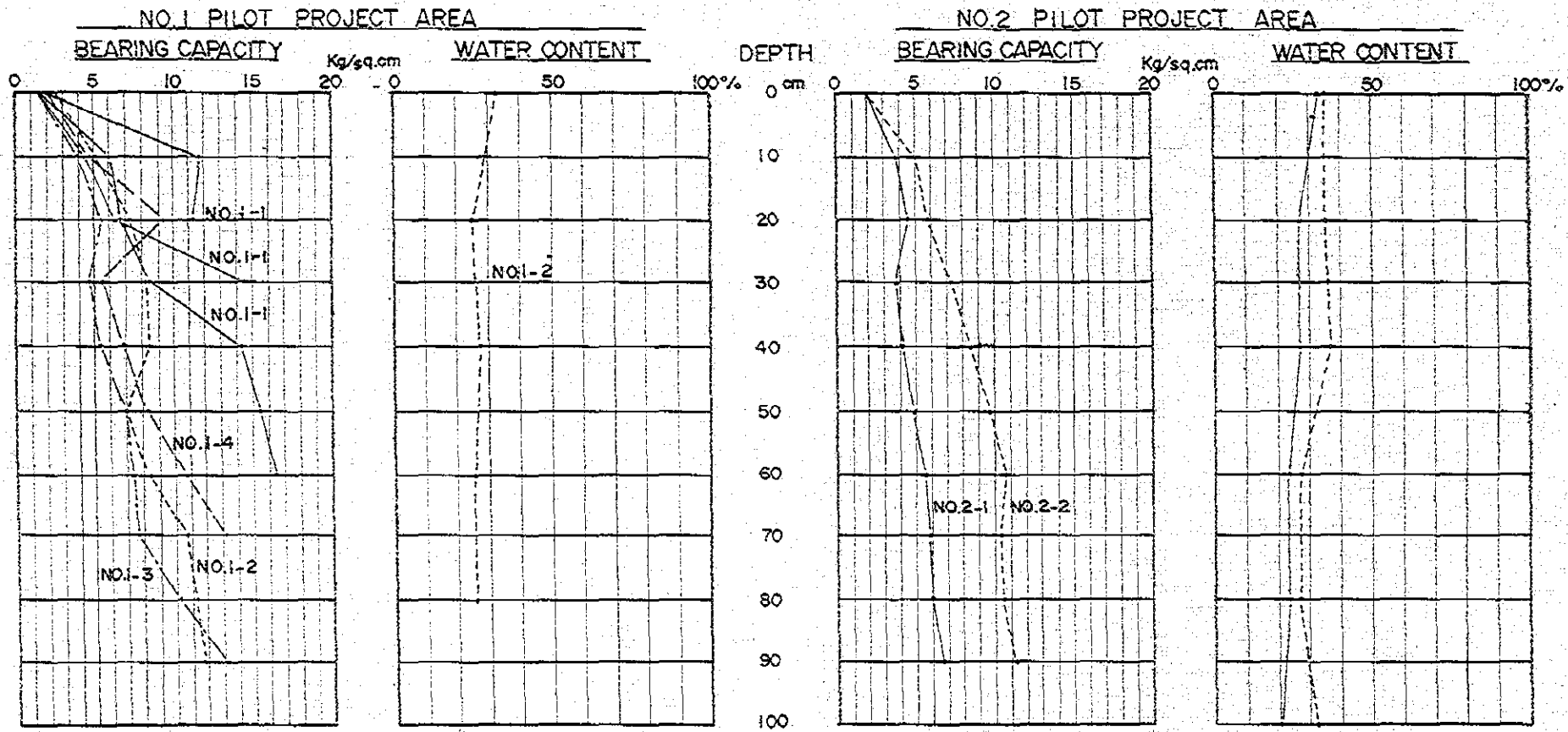
Bearing capacity

Paddy fields in the both Project Areas provide a sufficient bearing capacity in the irrigated condition, as shown in FIGURE 2-3, so that the tractors with 30-40 HP may be readily introduced to the fields.

ii) Chemical properties of soil

Chemical analysis of the soils revealed that there exist no particular elements harmful to the paddy and upland croppings. The soils show the Ph by 5.6 to 8.0, containing the effective phosphorus acid in the range between 270 ppm (max.) and 6 ppm (min.), and related CEC ranges 16.88 to 15-28 me/100 gr.

FIGURE 2-3 BEARING CAPACITY OF PADDY FIELD



NOTE : Surveyed in 28th and 29th September 1977.
Standing water is 5 to 20 cm in depth.

2-3. Present Irrigation and Drainage

2-3-1. The Mae Klong No. 1 Pilot Project Area

The No. 1 Pilot Project Area has been irrigated by concrete-lined IL-IR canal running along the Project Area. The water has been supplied to the Area through IL-IR canal after pumped up from the IR canal.

The commanded area by IL-IR canal is 8,907 rai (1,425 ha.) in gross and 8,016 rai (1,283 ha) in net. The No. 1 Pilot Project Area consists of 2,525 rai (402 ha) in gross, 28 percent of the relevant commanded area, and the allotted irrigation water is 0.30 cu.m/sec.

Dimensions of IL-IR Canal

Canal capacity: 1.064 cu.m/sec.
Gross area: 8,907.25 rai (1,425 ha)
Net area: 8,016.48 rai (1,283 ha)
Unit irrigation water: 0.13 l/s/rai (0.83 l/s/ha)
Water source: Pumping up from IR canal
Elements of pump (Capacity): 0.504 cu.m/sec/set
(No. of units): 3 sets (one spare unit)
(Operation time): 20 hrs/day
(Power): 20 KW, 380 volt.

Presently, the IL-IR canal functions only in the wet season for supplemental irrigation and does not in the dry season. Because excavation of drainage canal in the dry season at the upperstream of the Vajiralongkhorn Dam requires to lower the regulated design water level of the reservoir (EL 22.00) and this lowered water level allows water-intake to the IL-IR canal unavailable. The irrigation, therefore, will be available for the dry season cropping after completion of the said drainage canal.

In 1974, the ditch and dike project was implemented in the Project Area and its environs, so as to improve the on-farm irrigation

facilities and as a result, eight irrigation ditches were provided in the No. 1 Pilot Project Area at the intervals of 300 m or 400 m.

In the wet season, the irrigation water has been supplied by plot-to-plot manner to each plot through respective ditches. The area along the IL-IR canal has comparatively high elevation and steep land slope along ditches (1/600-1/1,000), which prevent the paddy fields between ditches from being irrigated sufficiently. The upland fields, concentrated along the IL-IR canal in small scale, cannot be irrigated due to their high elevation and low water level in the ditches. Other fields in the Area have been effectively irrigated.

Some paddy fields in the downstream have been suffered from deep water (more than 20 cm) due to no drainage ditches and gentle land slope.

There is inconvenience in accessing to the fields in the Area due to absence of adequate farm roads except for ridges.

2-3-2. The Mae Klong No. 2 Pilot Project Area

The No. 2 Area is irrigated by the concrete lined 3L canal running through the Project Area. The irrigation water is taken from left main canal to 3L canal and distributed to the fields after diverted by 11 turn-outs.

Dimensions of 3L Canal

Canal capacity: 0.541 cu.m/s.
Gross area: 3,734 rai (598 ha)
Net area: 3,361 rai (538 ha)
Unit irrigation water: 0.16 l/s/rai (1.01 l/s/ha)
Water source: Left main canal

For the No. 2 Area, as well as the No. 1, the ditch-and-dike project has been executed to provide ditches at the intervals of

300 m or 400 m for irrigation. However, the lower water level in 3L canal, which hinders smooth water intake, and rough networks of these ditches have prevented the No. 2 Area from being irrigated effectively as in the No. 1 Area.

Although the No. 2 Pilot Project Area is drained by the Tha Sarn drainage canal running at western and northern edge of the Area, absence of drainage ditches has caused deep standing water in the gentle land slope parts of the Area as well. The Tha Sarn Bang Phra drainage canal, running through the eastern part of the Area, does not function for the No. 2 Pilot Project Area due to higher elevation of its location.

2-4. Agriculture

2-4-1. Mae Klong No. 1, Pilot Project Area

a) Land Use

TABLE 2-3 illustrates the present land use in the No. 1 Pilot Project Area. Most of the Area (98.2%) is utilized as paddy fields, and sugar canes, chilies, etc. are cropped in the rest part of the fields.

TABLE 2-3. Present Land Use (No. 1 Pilot Project Area)

(Unit: ha)

Category	Acreage	Percentage
Farm lands	394.8	98.2%
Paddy fields	388.6	96.7
Upland fields	5.0	1.2
Sugar cane fields	1.2	0.3
Roads and canals	2.3	0.6
Residential lots	2.6	0.6
Ponds & others	2.3	0.6
Total	402.0	100%

b) Present Farming Practices

The main crop in the Area is conventional local varieties of paddy grown by transplanting. Such local varieties, which have photo-sensitivity, are transplated June through September according to rainfall condition and harvested end of November through middle of following January. The transplanting is carried out over a rather long period because most of the terminal irrigation facilities function ineffectively and the paddy fields have remained rainfed in totally depending upon unreliable rainfall in the early part of the wet season. Some farmers provide pumps to utilize the groundwater or ponds for effective use of the rainfall.

Plowing and puddling works are practised by large-type tractors on rental basis, power tillers or water buffalos. Most of the farmers carry out extensive farming, except very few providing shoulder-type sprayers.

Sugar canes are planted in April through May and harvested November through following April. The plants are renewed in the fourth year after two ratoonings over. The sugar cane fields in the Project Area, recently developed fields, are considered to provide favorable conditions to readily improve related farming works. Some farmers are growing maize between ridges of sugar cane fields for intensifying the cropping ratio. In the dry season, no other crops but for sugar canes can be seen in the Project Area.

The following TABLE 2-4 shows crop-wise cultivation acreages, unit yields and productions.

TABLE 2-4. Present Crop-Wise Cultivation Acreage, Yield and Production (No. 1 Pilot Project Area)

Crops	Acreage (ha)	Yield (Ton/Ha.)	Production
Transplanting paddy	388.6	2.2	859.9
Sugar cane	1.2	50.0	60.0
Upland crops	5.0	10.0	50.0

c) Input Materials and Labor Forces

In the Project Area, the paddy cropping is carried out in extensive manner that no application of improved techniques except fundamental practices such as plowing, puddling, sowing, transplanting and harvesting. The soils in the Project Area are less responsive to potassium fertilizers and it is recommended to employ the Nitrogen-phosphate compound fertilizers in the Project.

The farmers who have farm lands in the Project Area are about 86 and their families consist of 6.9 members on an average. The actual labor forces in the said family are computed by 3 persons per household (15-65 years old).

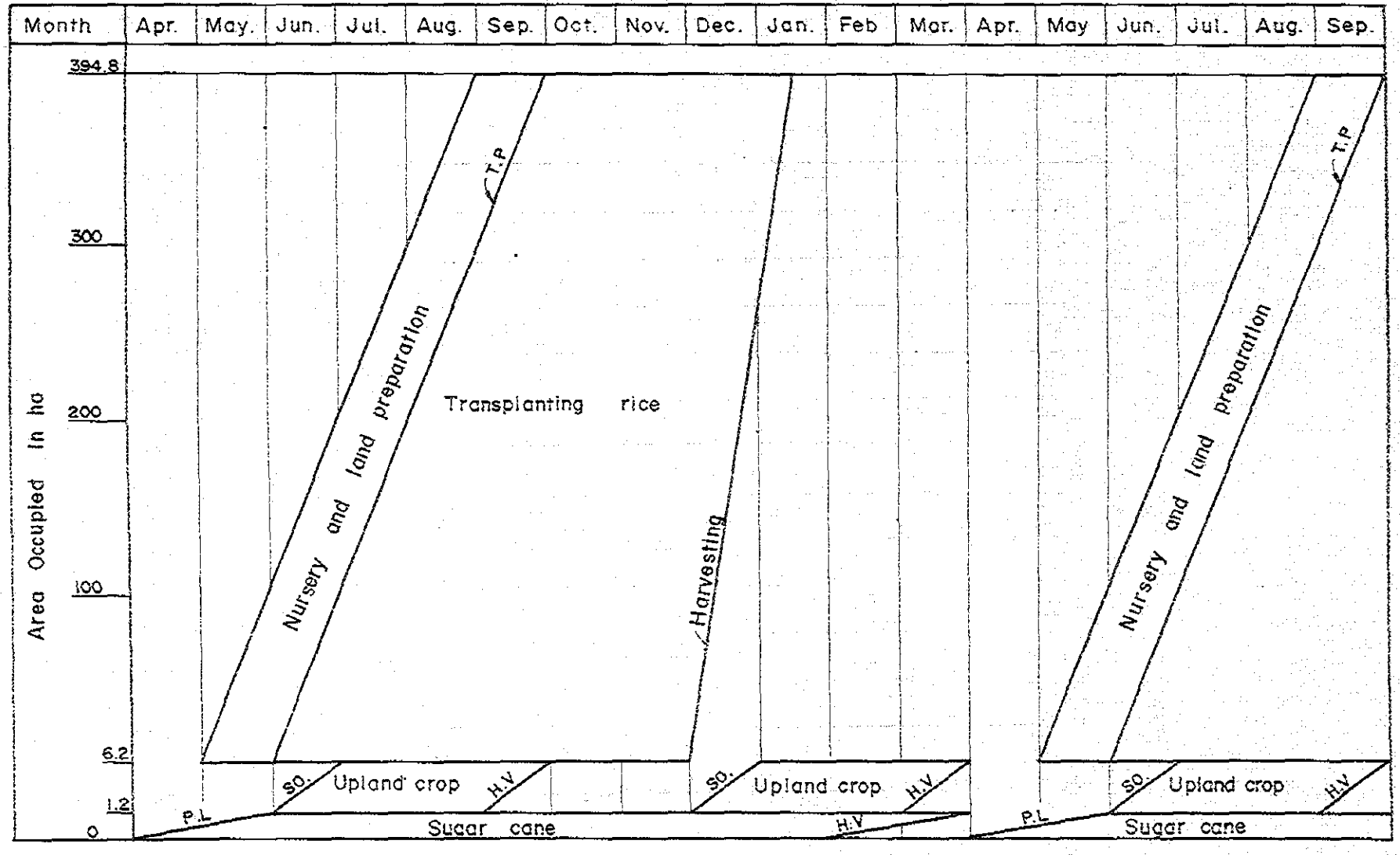
The monthly labor requirements on the basis of present cropping pattern are illustrated in FIGURE 2-5. In both seasons of transplanting and harvesting, the family labor forces cannot cover the whole works and the hired power is supplied from inside and outside the Project Area to meet the requirements. In the other seasons than the above, even the family power is excessive to some extent.

2-4-2. Mae Klong No. 2 Pilot Project Area

a) Land Use

TABLE 2-5 shows the present land use in the No. 2 Pilot Project Area.

FIGURE 2-4 PRESENT CROPPING PATTERN (NO.1 AREA)



Notes : T.P = Transplanting PL. = Planting
SO. = Sowing H.V = Harvesting

FIGURE 2-5 PRESENT FARM LABOR REQUIREMENT (NO.1 AREA)

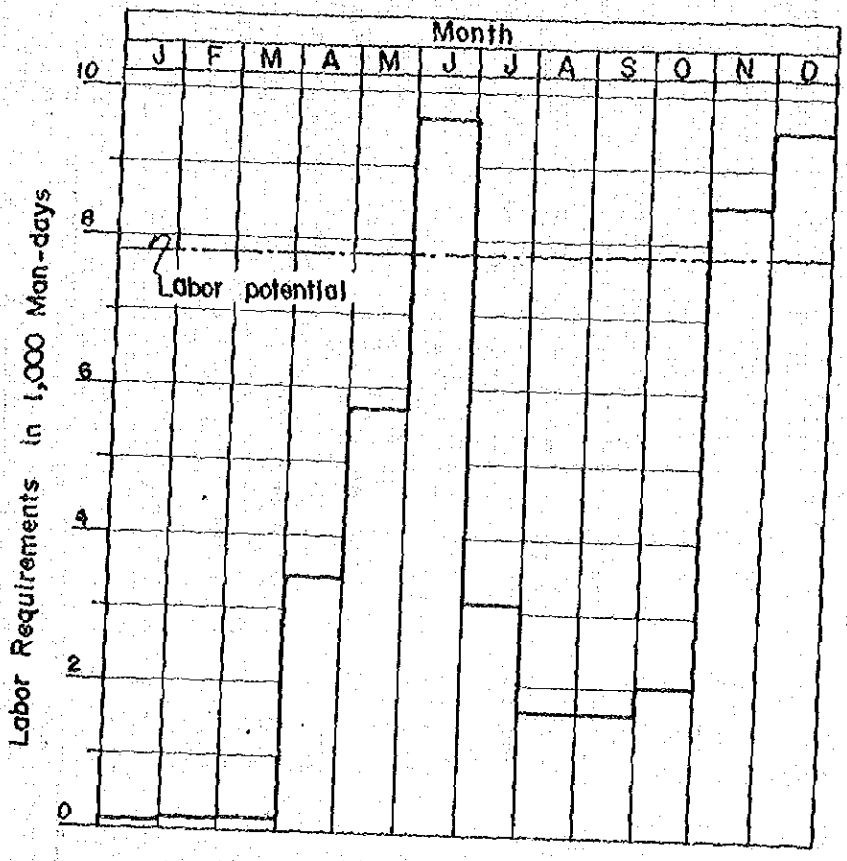


TABLE 2-5. Present Land Use (No. 2 Pilot Area)

Category	Acreage (ha.)	%
Farm lands	534.2	94.9
Paddy fields	511.2	90.8
Upland fields	2.0	0.4
Sugar cane fields	21.0	3.7
Roads & canals	28.0	5.0
Residential lots	1.0	0.1
Total	563.2	100

b) Present Farming Practices

The main crop in the Area is the conventional local varieties of paddy grown by transplanting. In some lowlying marshy lands, the direct sowing is carried out. Transplanting is made June through end of September and direct sowing is made end of April through June. Insufficient consolidation of the ditches between 3L canal and the terminals have kept most of fields rainfed, except for some along 3L canal.

In the lowlying marshy lands in the downstream portion of the Area, inundation takes place in the peak of the wet season and conventionally long-stalk paddy varieties are grown therein. However, the Tha Sarn River conservancy in 1977 will greatly improve the conditions of these inundated areas.

Plowing and puddling works have been carried out by various ways such as using large-type tractors on the rental basis, power tillers or carabaos. Transplanting has been made in the regular planting method (25 x 25 cm), and the farmers tends to plant deep. The paddy, which is conventional photo-sensitive varieties, has been harvested end of November through middle of January in cutting short from panicles with sickles. The local varieties in general have shattering habit, which reduces production due to losses in harvesting works.

The Mae Klong River Basin is in the so-called sugar cane belt in Thailand; particularly, the No. 2 Project Area is included in Amphoe Thamaka, the real center of the sugar cane growing. The sugar cane is planted April through May, when the irrigation started in the fields where the irrigation facilities are available. Several top dressing is carried out while plants growing, whereas the application of herbicides has scarcely carried out from the viewpoint of saving the cost against low market price of the products.

Besides the above crops, some fields in the No. 2 Pilot Project Area, located closely to vegetable producing Nakhon Phaton area, produce mongo beans, string beans, cibols, and chilies. However, some chili plants have been found infected with virus disease and renewal of species will be required.

In the dry season, the second crops are grown in some paddy fields along the canals, being irrigated by portable pumps or by manpower watering.

TABLE 2-6 illustrates the present crop-wise acreages of cultivated lands, yields and productions. In general, the yields of each crop are considerably low. The chilies are grown in the exclusive use of upland fields in the wet season, and the mongo beans in the paddy fields as the second crop in the dry season.

TABLE 2-6. Present Crop-Wise Cultivation Acreages, Yields and Production (No. 2 Pilot Project Area)

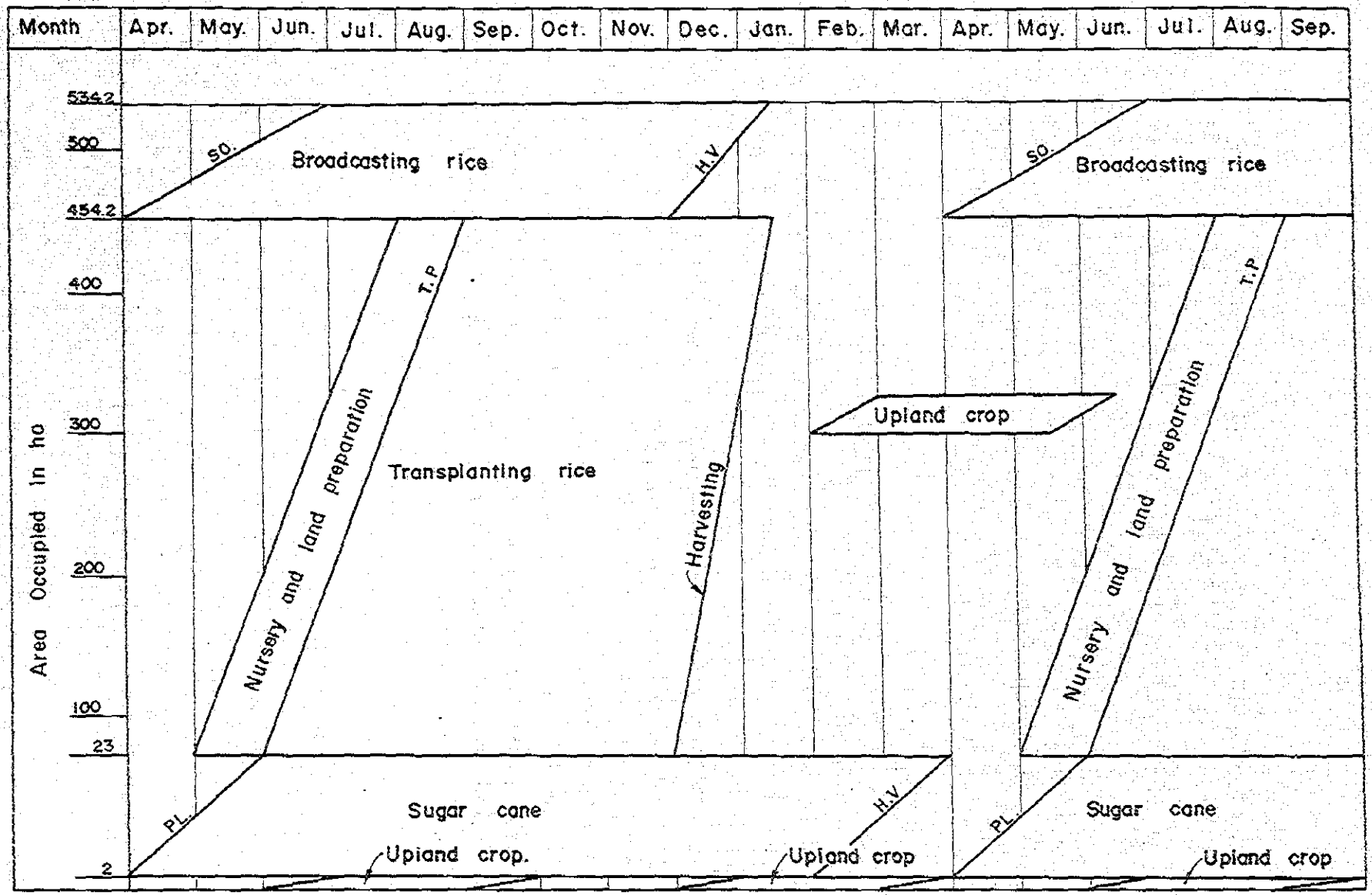
Crops	Acreage (ha)	Yield (ton/ha)	Production (ton)
Direct sowing paddy	80.0	1.6	128.0
Transplanting paddy	431.2	2.2	948.6
Sugar cane	21.0	50.0	1,050.0
Upland crops (chilies)	2.0	1.0	2.0
Uplnad crops (mongo beans)	26.3	0.8	21.0

c) Input Materials and Labor Forces

Paddy, especially direct sown paddy, is grown so extensively that no other proper practices are employed than plowing and sowing.

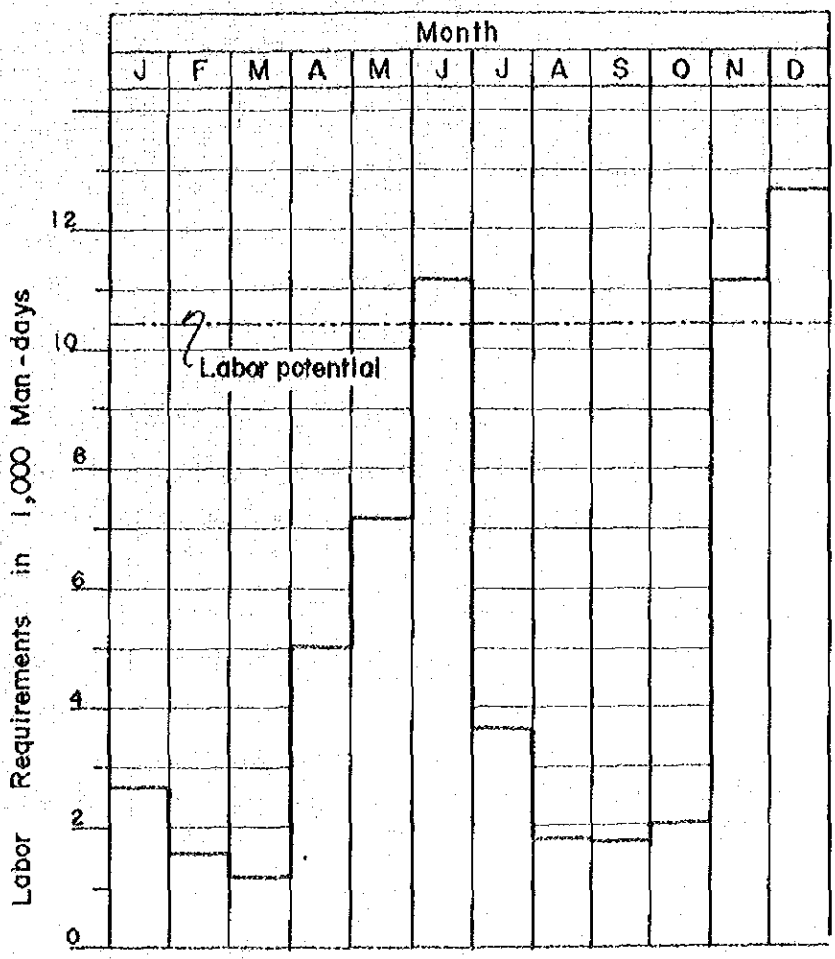
Transplanting paddy is grown in the same manner as carried out in the No. 1 Pilot Project Area. There are 114 farm households who hold the lands in the No. 2 Pilot Project Area, and a family consists of 6.9 persons on an average, including three available labor forces. The monthly labor requirements on the basis of present cropping pattern are shown in FIGURE 2-7 from which it is learned that in both seasons of transplanting and harvesting the family labor forces cannot cover the whole works.

FIGURE 2-6 PRESENT CROPPING PATTERN (NO.2 AREA)



Notes : T.P = Transplanting
SO. = Sowing
PL.= Planting
H.V = Harvesting

FIGURE 2-7 PRESENT FARM LABOR REQUIREMENT (NO.2 AREA)



CHAPTER 3. DEVELOPMENT PROGRAM

3-1. Development Strategy

3-1-1. Development Area

a) No. 1 Pilot Area

According to the mutual consensus achieved between both sides (Thailand and Japan) and after the studies on the topography, water resources, existing irrigation facilities and so forth, the Area of 402 ha in gross has been finally selected for the Project.

The Area extends in almost regular rectangular form and is bounded physically by IL-IR canal on the west, the road on the west, and the main drainage canal on the east.

The north boundary was determined so that the Project Area could cover about 400 ha in acreage and any inconvenience could not be imposed on the farmers who have a land on which the boundary line falls. In view of further expansion of the Project Area in the future, the north boundary was plotted in a right line (by road and canal).

The location hunting on the topo-map (1/4,000) for irrigable lands by 3L canal found about 676.2 ha. available for irrigated farming. These lands include 113 ha. of lands such as fragmentary lands unsuited to development, already well provided lands with irrigation facilities and available road system, and lands with no topographical data available.

Determination was made to exclude this land of 113 ha. from the Pilot project. Therefore, the gross acreage of the Project Area is 563.2 ha. However, since it is inevitable to involve the lands of 113 ha. for constructing irrigation systems, these lands are designated as "Related Area" of the Project.

3-1-2. Approach

a) Land Consolidation

The consultation between the Government of Thailand and Japan prescribes that the intensive land consolidation shall be applied to the No. 1 Pilot Project and the extensive land consolidation to the No. 2 Pilot Project.

The intensive land consolidation, which is planned to be introduced into the Chao Phya Pilot Project, does not provide only the irrigation facilities but also the general conditions of the farms to allow the improved farming to be available in the near future in concurrence with progress of agricultural technology. The intensive land consolidation will enable to provide the effective water management system, alleviate the hard farming works, and mechanize the farming works.

The extensive land consolidation aims mainly to improve the terminal irrigation facilities and provide the farm roads, and is ready to be converted to the intensive land consolidation when necessity arises in future.

The construction machinery to be provided will be operated in the No. 1 Pilot Project Area and then appropriated for the No. 2 Pilot Project Area construction.

b) Farm Management Program

The basic concept for Farm Management Program is formulated to increase the agricultural productivity in the Project Area by means of the following practice.

- Intensification of land use ratio by introducing paddy double-cropping and/or multi-cropping
- Increase of yield per unit area
- Diversification of crops

- Promotion of farm mechanization
- Implementation of improved farming

Intensification of land use ratio will require to consolidate the agricultural infrastructures and eliminate the bottlenecks for the development. As mentioned previously, the intensive land consolidation works will be realized in the No. 1 Project Area, by which the project is expected to contribute not only to increase the land use rate, but also to enable farm mechanization and crop diversification as the results of drainage improvement.

c) Irrigation

The water right in the wet season in both areas of No. 1 and No. 2 Pilot Project Area has been already identified as mentioned in the section on Irrigation and Drainage (item 2-3) of this Report, whereas the one in the dry season has not been yet.

The water right in the dry season should be identified on the basis of those plans for water resources development in the upstream basin of the Mae Klong River and on-farm development in the downstream basin.

The irrigation requirement in the Pilot Project was prepared on the following basic concept:

i) Peak irrigation requirement in the wet season

The water right in the wet season should cover the following range of demand in both areas:

No. 1 Pilot Project Area	Within 0.30 cu.m/s
No. 2 Pilot Project Area	Within 0.541 cu.m/s

ii) Peak irrigation requirement in the dry season

No. 1 Pilot Project Area: The water demands in two stages have been studied, since the dry season cropping has not been diffused yet in the Project Area and its vicinity.

First stage: This is the stage before diffusion of the dry season cropping in the command area of the IL-IR canal, and in the stage, the total water in the IL-IR canal can be taken into the Project Area.

Water available: 0.50 cu.m/s (operating one pump unit)
Capacity of IL-IR canal: 0.563 cu.m/s
One pump unit operation: 0.504 cu.m/s
Two pump unit operation: 1.008 cu.m/s
Duration of irrigation: 24 hours/day

Second stage: This is the stage for reducing the water demands in the Area by introduction of upland cropping, with the dry season cropping diffused, to the extent of demands covered by the water right.

The cropping patterns in the first and the second stages are illustrated in FIGURE 3-3.

No. 2 Pilot Project Area: The Area is independent area irrigated by 3L canal. The Area has a relation only with the irrigation schedule by the left bank main canal. The present irrigation capacity in the dry season of the left bank main canal is 10 cu.m/s, which will be increased with the water resources developed in the upstream basin. The plan for water intake in the No. 2 Area was formulated on the assumption that in the dry season water can be used up to 0.541 cu.m/s.

iii) Estimate of water requirement

The estimate of water demands was made on the respective cropping calendars shown in FIGURE 3-1, in employing the estimate standard shown in FIGURE 3-2.

Reference evapotranspiration (ETp): The Penman's equation was employed for estimation of reference evapo-transpiration using the meteorological data observed at the Kanchanaburi station.

The monthly reference evapotranspiration is listed below.

Monthly Evapotranspiration

Month	mm/d	Month	mm/d	Month	mm/d
Jan.	3.42	May	4.51	Sept.	3.54
Feb.	4.18	Jun.	4.06	Oct.	3.53
Mar.	4.80	Jul.	3.75	Nov.	3.43
Apr.	5.20	Aug.	3.80	Dec.	3.20

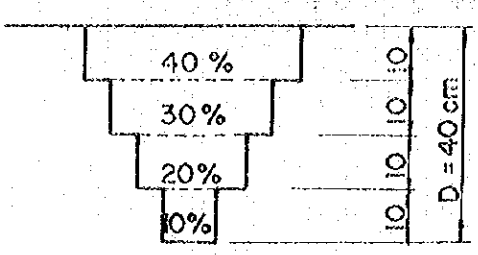
Annual Total: 1,441 mm

Consumptive use of crop (CU): The consumptive use of crops is obtained for each crop by multiplying a below-listed Crop Factor (K) by corresponding amount of evapotranspiration (ETp).

Crop Factor (K)

Growing Stage	High Yield Paddy	Local Variety Paddy	Upland Crops	Sugarcane
1	0.85	0.85	0.20	0.40
2	0.87	0.87	0.24	0.80
3	0.95	0.95	0.40	1.00
4	1.06	1.06	0.66	1.20
5	1.10	1.10	0.96	1.25
6	1.20	1.20	1.02	1.20
7	1.19	1.19	1.00	1.15
8	1.15	1.15	0.90	1.10
9	1.10	1.10	0.75	1.10
10	1.03	1.03	0.60	1.00
11	0.90	0.90	0.20	0.90
12				0.80

Field capacity. The maximum field capacity of water in paddy field is assumed to be 100 mm in depth. The field capacity in upland field mainly depends on the Total Readily Available Moisture (TRAM) inherent in the individual soils. Assuming that the following scheme presents the Soil Moisture Extraction Pattern (SMEP), the TRAM was determined from the result of the soil analysis to be 47 mm.



Field capacity (FC)..... 30.1% (by weight)
Moisture content at PF 3.8 (Wp) .... 22.2% (by weight)
Apparent specific gravity (Sa)..... 1.59

Percolation rate and other water requirement. The percolation rate in the paddy fields is determined to be 1.0 mm/day based on the field survey results and soil conditions. Other crops than paddy require 40 mm of pre-irrigation water before sowing. On the other hand, rice requires the following amounts of water for puddling and preparing the field.

(Unit: mm)

	Transplant field		Nursery bed	
	Dry Season	Wet Season	Dry Season	Wet Season
Preparatory	30	15	30	15
Puddling	160	160	120	120
Total	190	175	150	135

Irrigation efficiency. The following shows the estimated irrigation efficiency.

	Paddy Field	Upland Field
Field efficiency (Ef)	80%	65%
Conveyance efficiency (Ed)	90%	90%
Overall efficiency	72%	59%

Effective rainfall. Effective rainfall affects directly to the crop growth, and is determined by the following criteria:

- Initial loss is taken at 5 mm and the rainfall below 5 mm/day value is considered as ineffective.
- In the paddy fields, the rainfall up to 100 mm in depth is stored effectively and that exceeding 100 mm is ineffective.
- Effective rainfall in upland fields is determined by percolation rate and TRAM (47 mm).

The design rainfall, corresponding to the return period of 2 years and 5 years, is established as shown below, based on the rainfall record at the Tha Maka.

Design Rainfall (mm)

Month	T=2	T=5	Month	T=2	T=5	Month	T=2	T=5
Jan.	0	0	May	139.4	220.9	Sept.	230.5	122.9
Feb.	0	0	Jun.	107.0	79.7	Oct.	170.5	255.9
Mar.	0	0	Jul.	183.5	88.3	Nov.	0	25.7
Apr.	61.1	0	Aug.	173.0	75.0	Dec.	0	8.1

Annual total: T=2 years 1,065.0
T=5 years 876.5

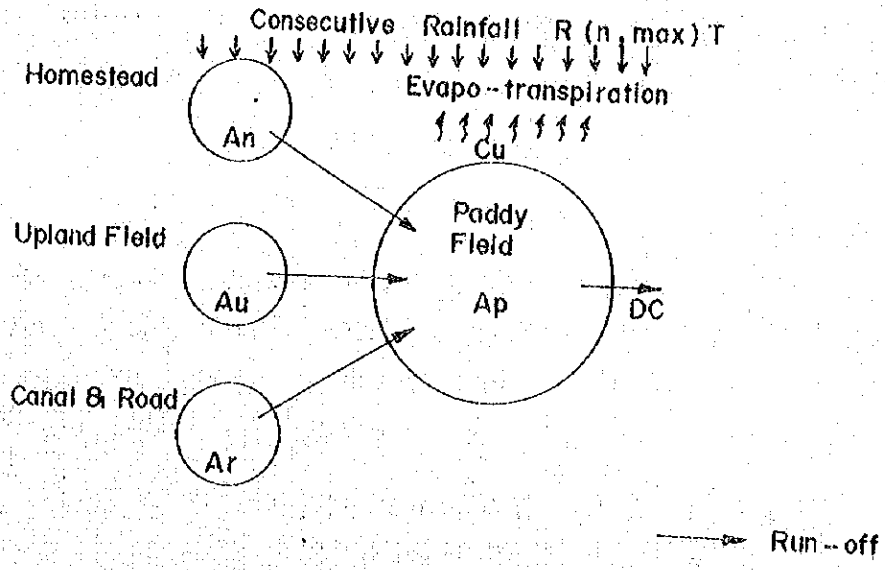
Irrigation requirement. The following is the definition of irrigation requirement applied to this study.

- Net water requirement (NWr) = CU + Pe
  Pe = Percolation loss
- Water requirement (Wr) = (NWr + Lp - E)/Ef
  Lp = Land preparation water
  E = Effective rainfall
  Ef = Field efficiency
- Diversion requirement (Dr) = Wr/Ed
  Ed = Conveyance efficiency

d) Drainage

The drainage system in the Project Area can be illustrated in the following model:

Drainage Model



	Homestead	Upland	Road	Paddy
Acreage (ha)	Ah	AU	Ar	AP
Runoff coefficient	fh =0.8	fu=0.7	fr=1.0	

CU: Evaporation from paddy field (4.0 mm/day)

DC: Discharge capacity (mm/day)

$R(n, max)_T$: Consecutive rainfall for n days with the return period of T years

In the above-mentioned drainage model, an assumption was made that rainfall on homesteads, uplands and roads is drained down in a day into the paddy fields. Given that Dn presents flood water depth in the paddy fields at the final day of the n-days consecutive rainfall; Dn is expressed in the following formula:

$$Dn = [R(n, max)_T - n.DC - n.CU] + \frac{R(n, max)_T}{Ap} (Ah.fh + AU.fu + Ar.fr) \quad \ldots (3.1)$$

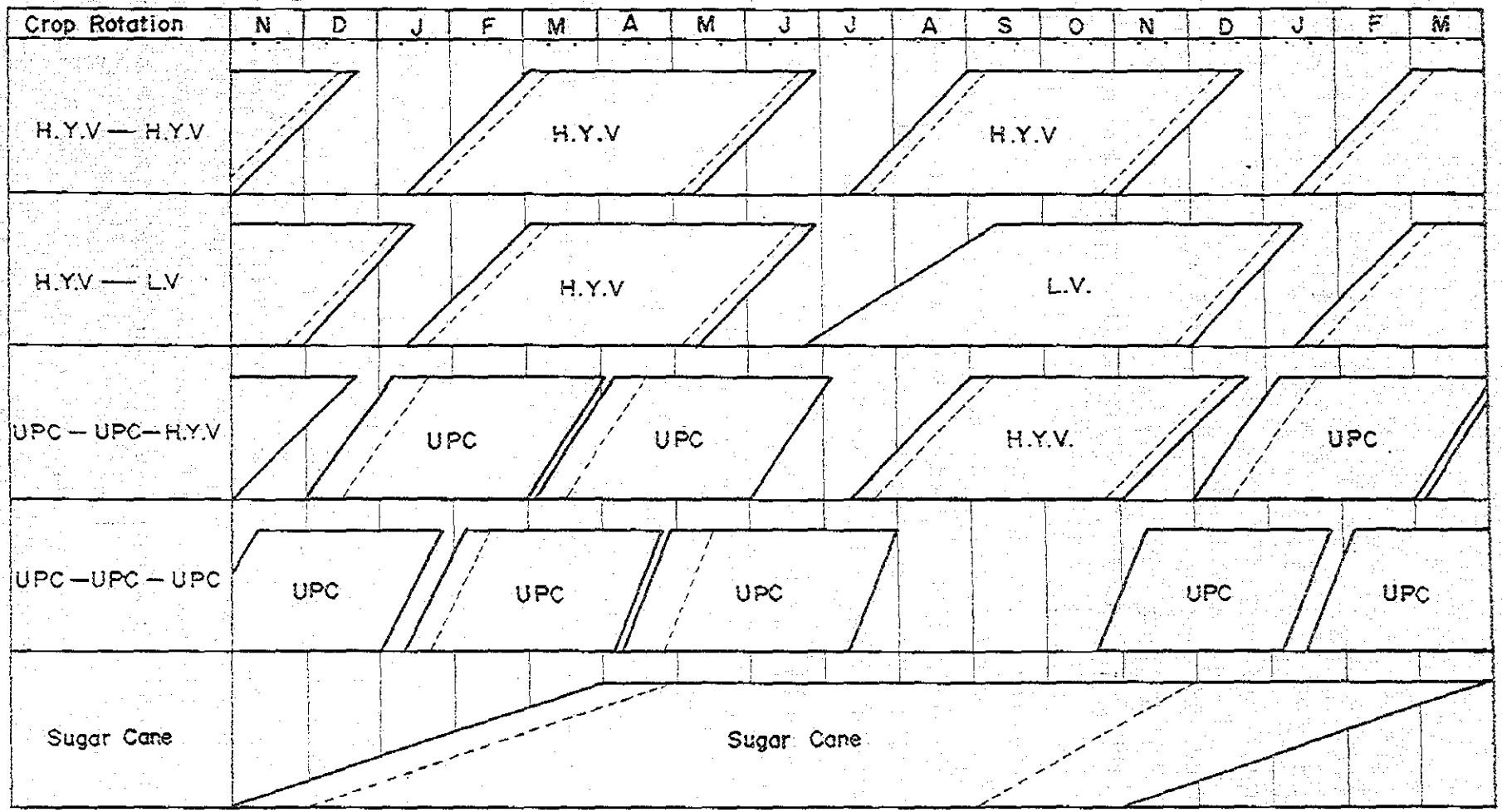
In this project, allowable inundation depth in the paddy fields is pre-determined to be 100 mm ($DC \leq 100$ mm). The following probable rainfall with the return period of 10 years is adopted as the design rainfall.

Daily rainfall;	$R(1, max)_{10}$ =	141 mm
2-days rainfall;	$R(2, max)_{10}$ =	177 mm
3-days rainfall;	$R(3, max)_{10}$ =	209 mm

e) Agricultural Supporting Service

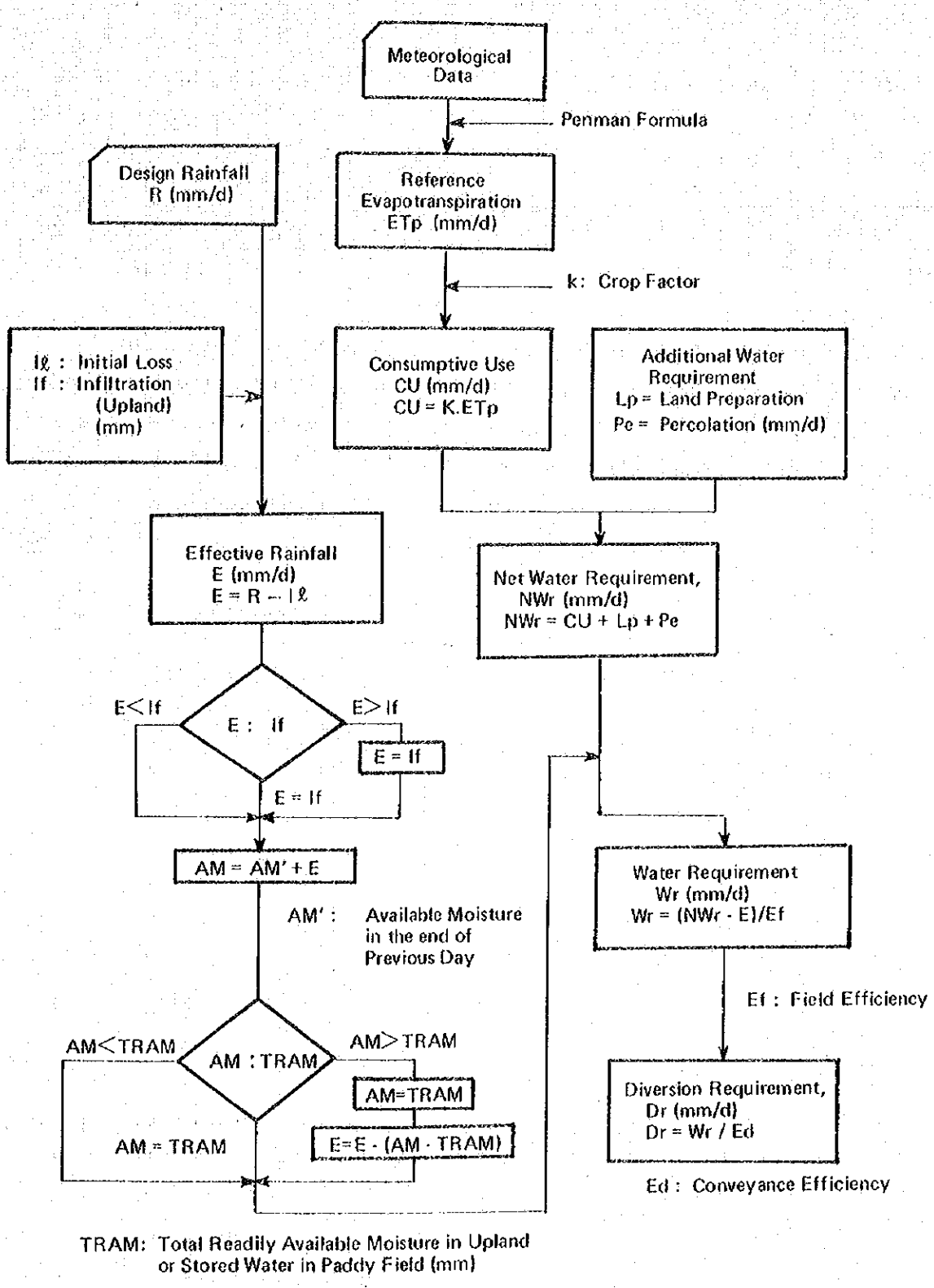
The key point of the successful implementation of the Project is to provide a practicable working system for the farmers in view of the agricultural development in the tropical zone. In this respect, it is planned to render the so-called agricultural supporting services through applicability tests of techniques, which will be carried out in the Project, and diffusion of the improved techniques developed in the Suphanburi Rice Experimental Station.

FIGURE 3-1 PROPOSED CROP ROTATION



Notes : H.V.Y = High Yielding Varieties Paddy
L.V. = Local Varieties Paddy
UPC = Upland Crops

FIGURE 3-2. PROCEDURE OF WATER REQUIREMENT ASSESSMENT



For realizing the agricultural supporting service, construction of a trial farm and designation of model farms in the No. 1 Pilot Project Area are proposed.

3-2. No. 1 Pilot Project

3-2-1. Farm Management Program

a) Land Use

TABLE 3-1 shows the proposed land use to intensify land use ratio by paddy double cropping and diversification of crops. The land consolidation for the existing farm lands of 394.8 ha will reduce the said acreage to 362.1 ha at the land deduction ratio of 5.9% for the lots of canals, roads and other structures.

TABLE 3-1. Proposed Land Use
(No. 1 Area)

(Unit: ha.)

Land Category	Present	Proposed
Cultivated lands	394.8	362.1
Paddy field	388.6	324.8
Upland field	5.0	36.2
Sugarcane	1.2	1.1
Roads, Canals	2.3	24.9
Trial farm	-	9.9
Homestead	2.6	2.6
Others	2.3	2.5
Total	402.0	402.0

NOTE: Land deduction rate = (394.8 - 9.9 - 362.1)/(394.8 - 9.9)
= 5.9%

b) Cropping Pattern

The proposed cropping pattern is formulated with paddy as main crop and sugarcane and pulses (cash-crops) are planned to be grown in

upland fields. In the dry season, paddy fields are cultivated with upland crops to retain the soil fertility (FIGURE 3-3). The proposed paddy varieties are the RD strains with high yielding, non-photosensitivity, early maturing and short-stem. The growth period of the RD strains is 125 days in the wet season and 130 days in the dry season. Considering available manpower in the peak time and water supply, puddling and transplanting shall be performed for 48 days in both wet and dry seasons.

As mentioned previously, the cropping pattern in the No. 1 Project Area is divided into two stages in terms of its progress: one of which is the first stage where the cropping in the dry season is not fully established in the 1L-1R canal district and the other is the second stage where the cropping in the dry season has become satisfactory.

c) Agricultural Production

The improved farming techniques to be introduced in the Project Area with agricultural infrastructures consolidated will allow the yields increase as shown below.

Target Yields

Crops	ton/ha
Wet season paddy, HYV	4.2
Dry season paddy, HYV	4.7
Soybeans	2.0
Mongo beans	1.2
Cabbage	12.9
Sugarcane	80.0

Accomplishment of the above target yields, however, indispensably requires the adequate agricultural supporting services with due consideration on the following matters. TABLE 3-2 shows the target production with Project and the expected increased production.

- Systematical supply and periodical seed renewal of HYV varieties of the pure strains.
- Adequate fertilization on the new application standard.
- Establishment of pest control system.
- Harvesting in the wet season.
- Extension of upland irrigation techniques.
- Establishment of mechanized farming.
- Establishment of marketing system of farm products.

TABLE 3-2: Target Production (No. 1 Area)

Crops	Target Production		Present Production	Increased Production
	Acreage (ha)	Production (t)	(t)	(t)
Paddy				
Dry season	324.8	1,364	-	1,364
Wet season	324.8	1,527	860	667
Total		2,891	860	2,031
Upland crops				
Vegetables	3 x 18.1	700	50	650
Pulses	3 x 18.1	87	-	87
Sugarcane	1.1	88	60	28

d) Labor Requirements and Agricultural Inputs

FIGURE 3-4 shows the estimated monthly labor requirements on the basis of the proposed cropping pattern. At present, the labor shortage has taken place in only transplanting and harvesting seasons; however, the family labor forces (3 persons/household) will be insufficient to cover the labor requirement in four months of February, March, June and November under the proposed cropping pattern with land use ratio considerably intensified.

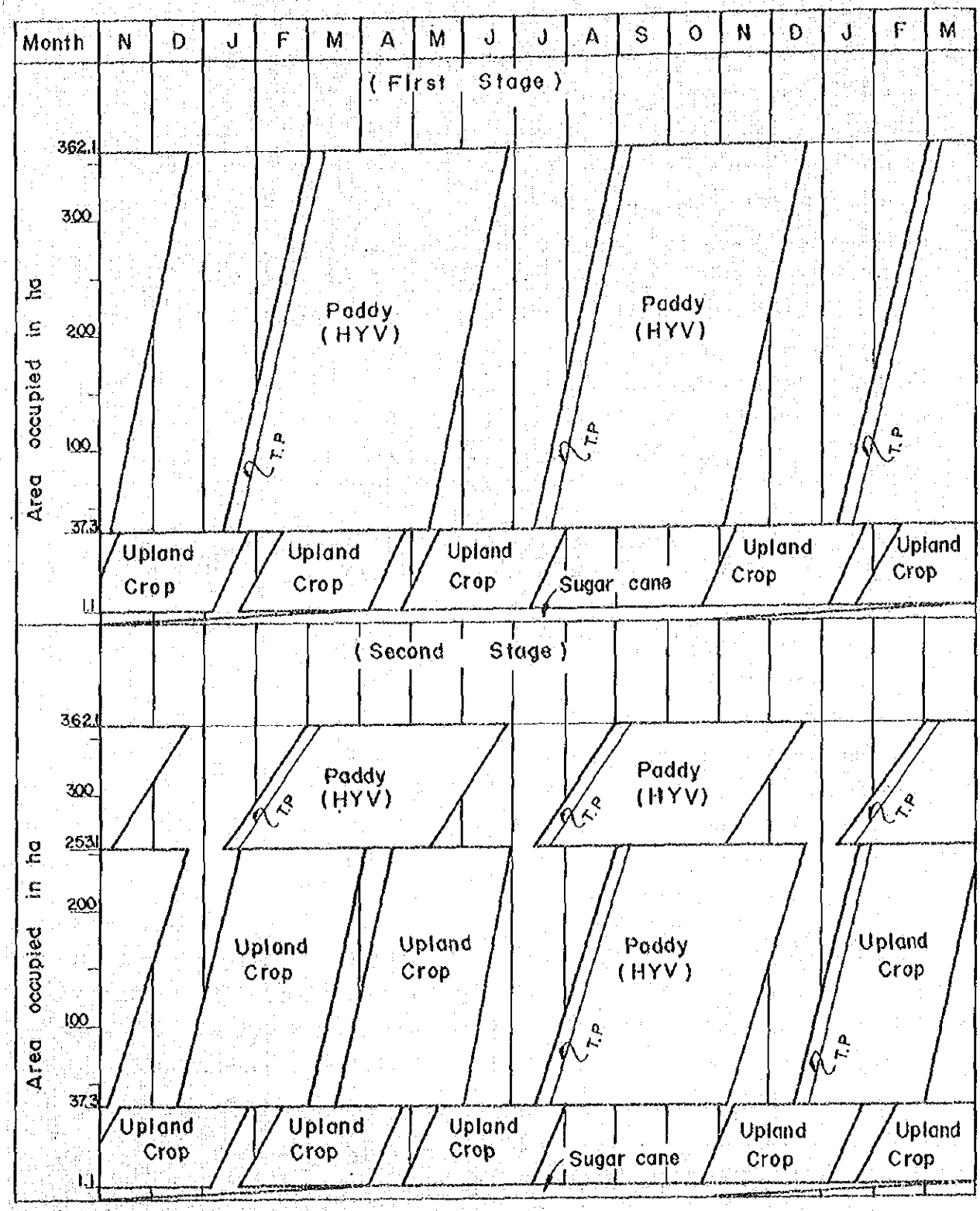
For the time being, such labor shortage will be covered by employed labor forces from the vicinity of the Project Area, and the farm mechanization may be indispensably required to cope with the progress of the regional development.

The necessary amount of agricultural inputs such as pesticides, fertilizers, renewal seeds, etc., should be timely supplied to achieve the target in the yields. TABLE 3-3 shows the inputs required for the successful implementation of the Project. The paddy seeds should be renewed at least once for every four croppings. The Suphanburi Rice Experiment Station reserves the pure-line seeds to supply to the trial farm to be provided in the Project Area for their multiplication. The multiplicated seeds shall be distributed to the related farmers through the farmers' organization. The necessary amount of paddy seeds is shown in the following TABLE 3-4.

TABLE 3-3. Agricultural Inputs
(No. 1 Pilot Project Area)

Items	Unit Quantity (kg/ha)	Cropped Acreage (ha)	Amount Required (ton)
Fertilizers			
Dry season paddy	262	324.8	85.1
Wet season paddy	220	324.8	71.5
Upland crops	636	3 x 36.2	69.1
Sugarcane	446	1.1	0.5
Pesticides			
Dry season paddy	21.2	324.8	6.9
Wet season paddy	21.2	324.8	6.9
Upland crops	372.3	3 x 36.2	40.4
Sugarcane	12.2	1.1	0.1

FIGURE 3-3 PROPOSED CROPPING PATTERN (NO.I AREA)

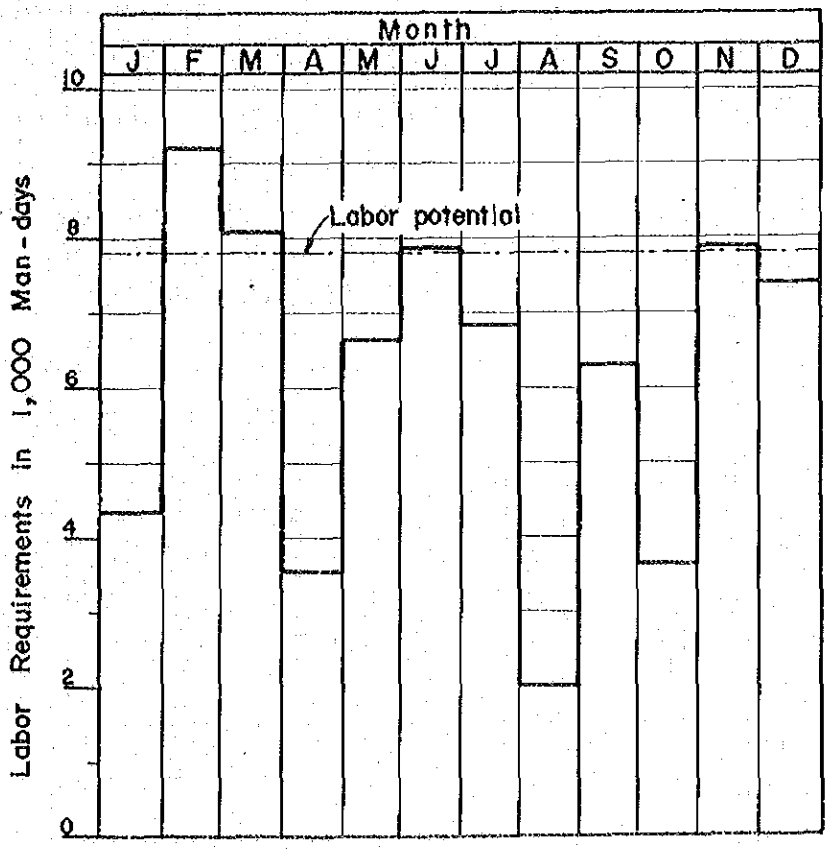


Notes : T.P = Transplanting
HYV = High Yielding Varieties

TABLE 3-4. Necessary Amount of Seeds
(No. 1 Pilot Project Area)

Crops	Unit Quantity (ton/ha)	Cropped Acreage (ha)	Amount Required (ton)
Wet season paddy	0.04	324.8	13.0
Dry season paddy	0.04	324.8	13.0
Mongo beans	0.042	3 x 18.1	2.3
Cabbages	0.002	3 x 18.1	0.1
Sugarcane	6.2	1.1	6.8

FIGURE 3-4 PROPOSED FARM LABOR REQUIREMENT(NO.1 AREA)



3-2-2. Agricultural Infrastructure Consolidation

The plan of consolidation works of the No. 1 Area is formulated as shown in FIGURE 3-5. It is expected by the implementation of the works that the cropping pattern and water control will be thoroughly systematized and consequently the farming and utilization of water will be significantly improved. The well levelled farm plots will provide rice with the most favorable growing condition, and accurately controlled irrigation system will bring great increase of income to the regional farmers.

The density of the proposed roads and canals per hectare, the estimated costs per hectare for land consolidation works and the farm land reduction rate for public use are summarized as follows:

Density of road and canal (m/ha)

Road		Irrigation		Drainage	
Community road	29	Lateral	23	Lateral	16
Farm road	33	Ditch	37	Drain	38
Total	62		60		54

Construction cost: 3,255 ฿/rai (1,062 US$/ha)

Reduction rate of farm lands: 5.9%

a) Irrigation

i) Annual irrigation program

The irrigation program of the No. 1 Project Area will be promoted in two stages as mentioned in paragraph 3-1-2. FIGURE 3-6 shows the annual irrigation schedule of each stage based on the proposed cropping pattern.

The peak irrigation requirements will occur twice in the latter half of the dry season (March) and wet season (October). To cope with such a critical condition, the pumping station of the IL-IR Canal should be operated with the rate of 24 hrs/day for about 10 days.

ii) Peak irrigation requirement

The peak irrigation requirement determines the capacities of the irrigation systems. The peak irrigation requirement will occur in the last day of puddling periods for dry season paddy cropping, and is designed as shown below:

Peak requirement		Designed capacity	
Water requirement:	9.65 mm/d	Farm ditch:	1.25 l/s/ha (or 0.024 cu.m/s/19.2 ha)
Diversion requirement:	10.72 mm/d (or 2.241 l/s/ha)	Lateral canal:	1.241 l/s/ha
Total requirement:	0.48 cu.m/s	Trial farm:	4.78 l/s/ha
(farm land	362.1 ha)		
(trial farm	6.33 ha)		

b) Drainage

The calculation of proposed drainage capacity was made applying the probable daily maximum rainfall of 141 mm exceeded in one out of ten years, and resulted in a DC rate of 43.3 mm/d (or equivalent to 5.01 l/s/ha).

c) On-farm land development

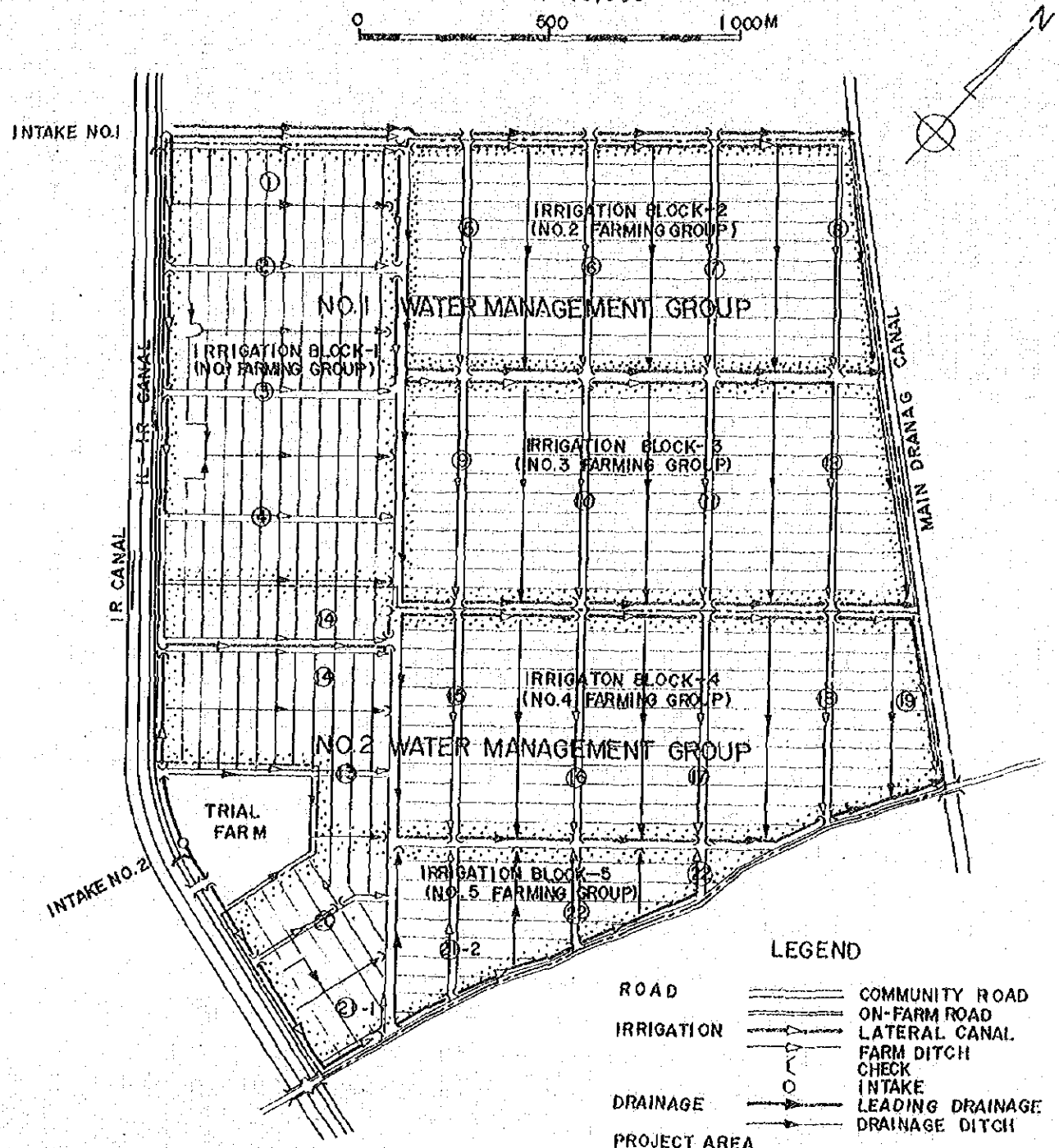
The intensive method is applied to the land consolidation plan of the Area. The land consolidation works include the following construction works; that is, lateral canal and farm ditch, leading drainage canal and drainage ditch, community road and on-farm road, and land levelling.

In planning the reparceling of land, the basic plan has been formulated taking the proposed farming practices, irrigation rotation and farming groups into consideration. Based on experiences gained with land consolidation works in Japan and in East Asia, the following are particularly proposed as the fundamental criteria to be adopted for the works in the Project.

FIGURE 3-5

ROAD AND CANAL NETWORKS OF MAE KLONG NO.1 PILOT PROJECT

SCALE 1 : 16,000



NOTE 1. PROJECT AREA = 402 ha

2. ORGANIZATIONS

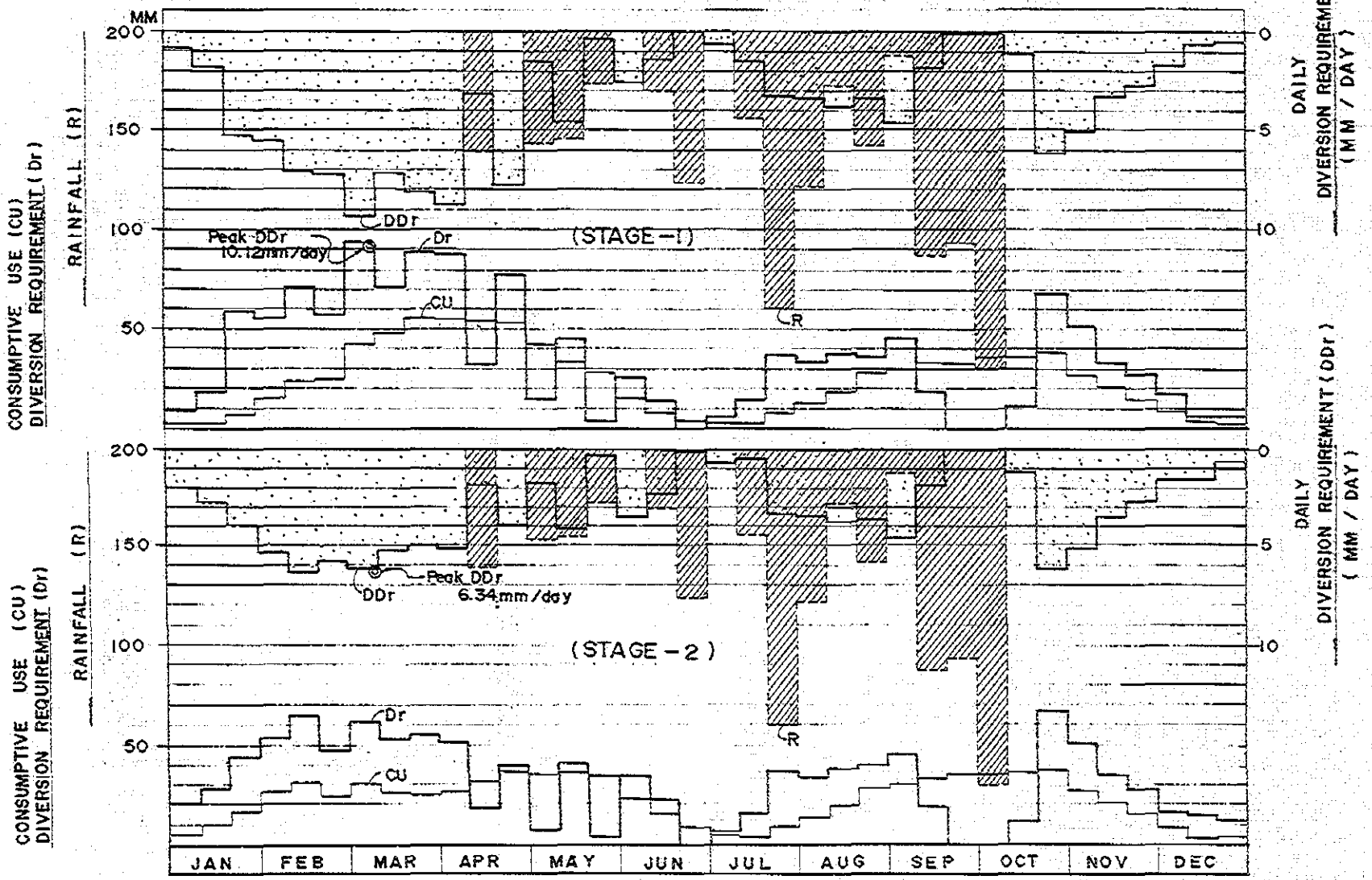
FARMING GROUP : Project consists of 5 farming groups.

WATER MANAGEMENT GROUP : Project consists of 2 water management groups.

FIGURE 3-6

ANNUAL IRRIGATION SCHEDULE IN NO.1 PILOT PROJECT

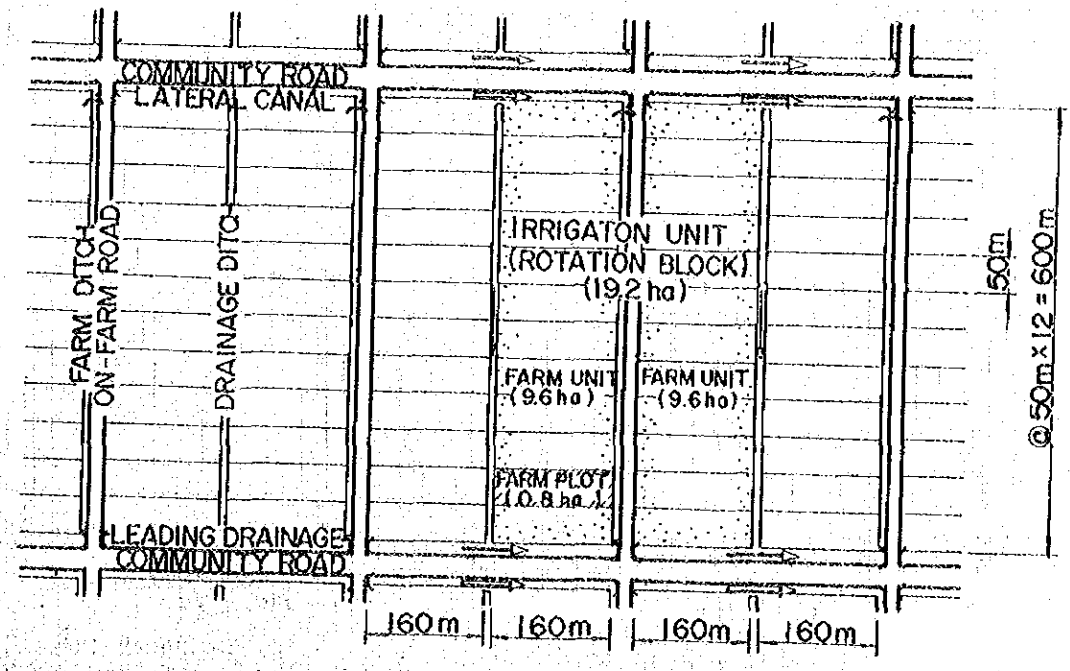
(IN NORMAL YEAR)



Farm plot. From the viewpoints of exchange and consolidation of farm land, operation efficiency of farming machines and effective water management, the shape of plots should be of uniformed rectangle. So far as conditions permit in water management and levelling accuracy, the possibly longer length of run will be advantageous for reducing the deduction rate of land and efficient operation of farming machines. It is deemed reasonable to take a length of run at 160 m in the Area. The width of plot will be reasonably taken at 50 m in the Area, which extends flat and has no restriction from the topographical conditions.

With the completion of the project, 461 of farm plots will be formed in the Area except the trial farm.

Irrigation unit. For a consideration of the water management, the suitable length of a farm ditch will be 600 m at maximum. The one irrigation unit, 19.2 ha, will be composed of 24 plots as illustrated below.



Road. Every plot should face the on-farm road at the shorter side of its plot. The community road, which will be paved with laterite materials, should run along the length of run at 600 m interval. The lower the road embankment height is, the more economical the construction cost and the easier the access of the farming machines will be, while the road embankment should require to have its height to the certain extent that the road surface can keep its bearable capacity in being free from the adverse effect of the water levels in the canals or paddy fields. Then, the community road embankment height, in view of soil properties of the Area, was designed to be 0.2 m higher at least than the water level in the canals, and the on-farm road to be 0.1 m.

Canal. The farm ditches will be provided along the one side of the on-farm roads. The drainage ditch aims to control the shallow ground water table as well as to drain out the excess water by rainfall as soon as possible. However, it is hardly expected to lower the shallow groundwater table in the irrigation period due to poor permeability of soils in the Area.

Resting place. It is proposed to establish two resting places at where the trees from the farm lands will be transplanted and be used by farms to have a rest as well as parting areas. Furthermore, the places could be used as public facilities lots in future, when necessitated.

Existing other facilities in the Area. In the Project Area there are several private properties other than farm lands, such as houses, homesteads and fishponds. In the planning, the following are taken into consideration: 1) every house is provided with a farm road, and 2) the proposed irrigation systems facilitate the water intake for fishponds. The houses and fishponds will be left untouched, however, it is recommendable to reform the shape of homesteads and fishponds in accordance with the proposed alignment of road and canal systems, when the owners agree.

Most of trees in the Area seem necessary to be cut down or transplanted for the execution of land consolidation works. The worthy tree designated by the owner will be left as it is or transplanted to the suitable location.

Adjacent farm lands to the north boundary. The following consideration is given to the farm lands to be divided by the northern boundary line of the Project Area:

- Drainage: to provide a drainage canal along the boundary line.
- Access: to provide a road along the drainage canal and drainage box culverts to cross the road with the interval of about 300 m.

With regard to irrigation, no particular ditch is proposed due to unfavorable topographic conditions, however, since the farm lands are presently equipped with ditches, the construction of the land consolidation works will not hinder those farm lands as far as irrigation is concerned.

d) Water Management

After the completion of the irrigation and drainage facilities, advanced water control techniques must be introduced in the Area. The facilities for water control should be those which allow the accurate water control without requiring complicated operation and particular knowledge.

i) Water management system

The project includes two of water control systems, Intake No. 1 and Intake No. 2, each of which is composed of the following three sub-systems:

Sub-system	Facilities
Intake sub-system	Check, intake
Conveyance sub-system	Check, diversion, lateral canal
Distribution sub-system	Farm ditch, farm inlet

As the irrigation water for the Area is lifted up with the pumping station installed at the head of the IL-IR canal, constant discharge in the canal can easily be maintained, by which, the rather simplified water control from the IL-IR canal to the lateral canal is expected.

ii) Water control facilities

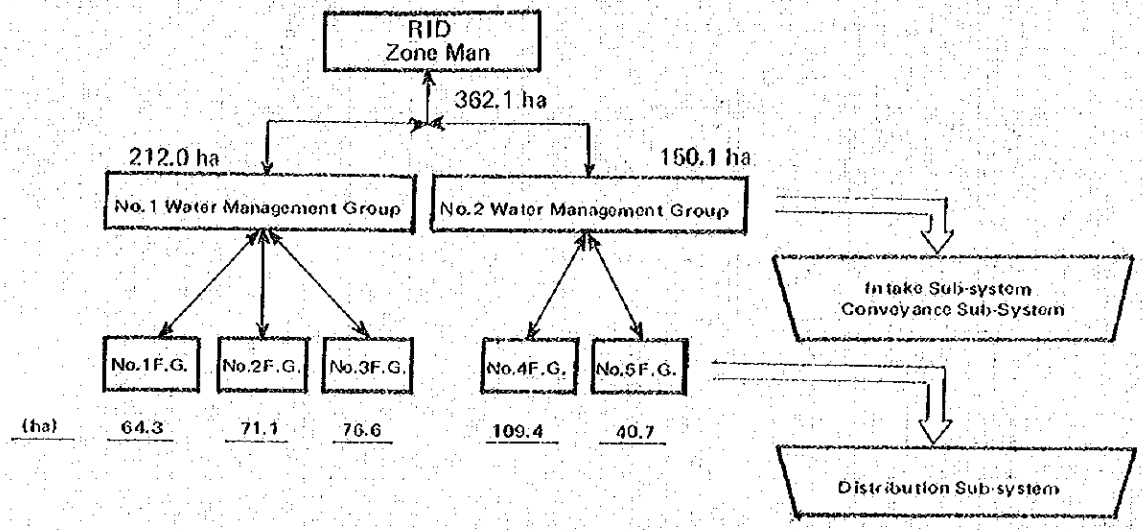
Intake sub-system. The intake sub-system has the functions of water intake from the IL-IR canal and the distribution of the water to the lateral canals. The facilities consist of an intake weir and a check gate that is to be installed in the IL-IR canal to keep the water level constant.

Conveyance sub-system. The conveyance sub-system is composed of such facilities as lateral canals, diversion and check gate, and has the functions of conveying the water to the farm ditches through the lateral canals. The construction of the check gates is proposed to keep a constant water level in the lateral canal for accurate water diversion, though the irrigation requirement seasonally fluctuates.

Distribution sub-system. The distribution sub-system is the terminal system, and each sub-system commands one irrigation unit composed of 24 farm plots. One sub-system consists of one farm ditch and six farm inlets that distribute the water from the farm ditch into the farm plots. Each one farm inlet covers four farm plots.

During the land preparation period of paddy fields, the rotational irrigation method is proposed to irrigate one distribution sub-system (24 farm plots) for a 48 days period, by supplying water at the rate of two days per farm plot.

In the No. 1 Area, it has been proposed to establish two water management groups and five farming groups for better water control. The proposed water management system is given below.



3-2-3. Design

a) Irrigation Facilities

i) Intake facilities

Two intake facilities are proposed to be installed in the IL-IR canal, No. 1 intake at the Station KM.5 + 561.38, No. 2 intake at the Station KM.7 + 424.38, respectively.

Designed capacity. The designed capacities of the intake facilities are calculated as shown in TABLE 3-5.

TABLE 3-5. Designed Capacity

Intake	Irrigation area (ha)	Intake (cu.m/s)	Diversion (cu.m/s)	Lateral Canal
No. 1	212.0	0.263	0.080	L 1-4.1
			0.183	L 1-1.1
No. 2	156.43	0.217	0.136	L 2-1.1
			0.051	L 2-2.1
			0.030	L 2-3.1
Total	368.43	0.480	0.480	

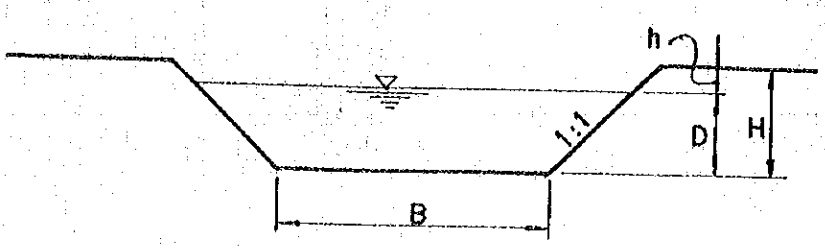
Structure. The designed check gate is of the manual-operated sluice gate type. A weir of the full-width sharp crested type will be equipped with each intake facility to measure the intake water discharge. The outlines of the intake facilities are illustrated in FIGURES 3-7 and 3-8.

ii) Irrigation canal

The proposed longitudinal slope of the canal shall not be less than 1/5,000. In hydraulic computation of cross-section of canals, the Manning's equation was employed in taking the roughness coefficient at 0.035. The canals shall provide the cross-section with the broader bottom for easy operation and maintenance, rather than that with hydraulic advantage, as listed below

Canal	Discharge (c.m/s)	Slope	B (m)	D (m)	H (m)
Lateral canal					
L 1-1.1	0.183	1/2,000	1.00	0.45	0.65
L 1-2.1	0.088	1/5,000	0.90	0.40	0.60
L 1-3.1	0.095	1/2,600	0.70	0.40	0.60
L 1-3.2	0.095	1/5,000	1.00	0.40	0.60
L 1-4.1	0.080	1/5,000	0.70	0.40	0.60
L 2-1.1	0.138	1/5,000	1.30	0.45	0.65
L 2-1.2	0.138	1/5,000	0.60	0.40	0.60
L 2-1.3	0.114	1/2,000	1.20	0.40	0.60
L 2-2.1	0.050	1/5,000	0.50	0.40	0.60
L 2-2.2	0.048	1/5,000	0.50	0.40	0.60
Farm ditch					
FD-1	0.024	1/1,000	0.30	0.25	0.35
FD-2	0.024	1/3,000	0.40	0.25	0.35
FD-3	0.024	1/5,000	0.50	0.25	0.35

Typical Cross-Section



h; freeboard

Lateral canal h=0.20 m
Farm ditch h=0.10 m

FIGURE 3-7 PLAN OF INTAKE NO.1

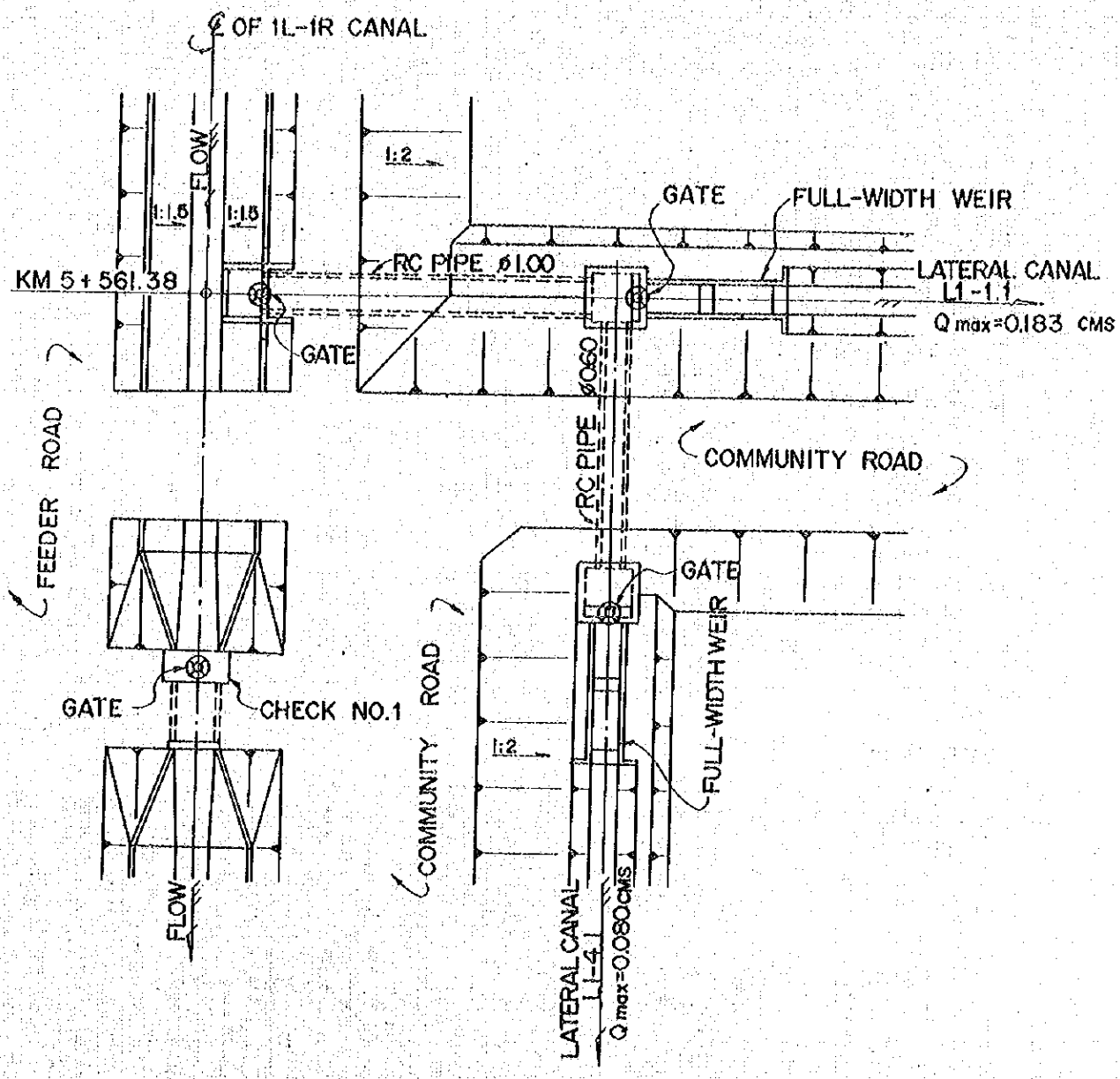
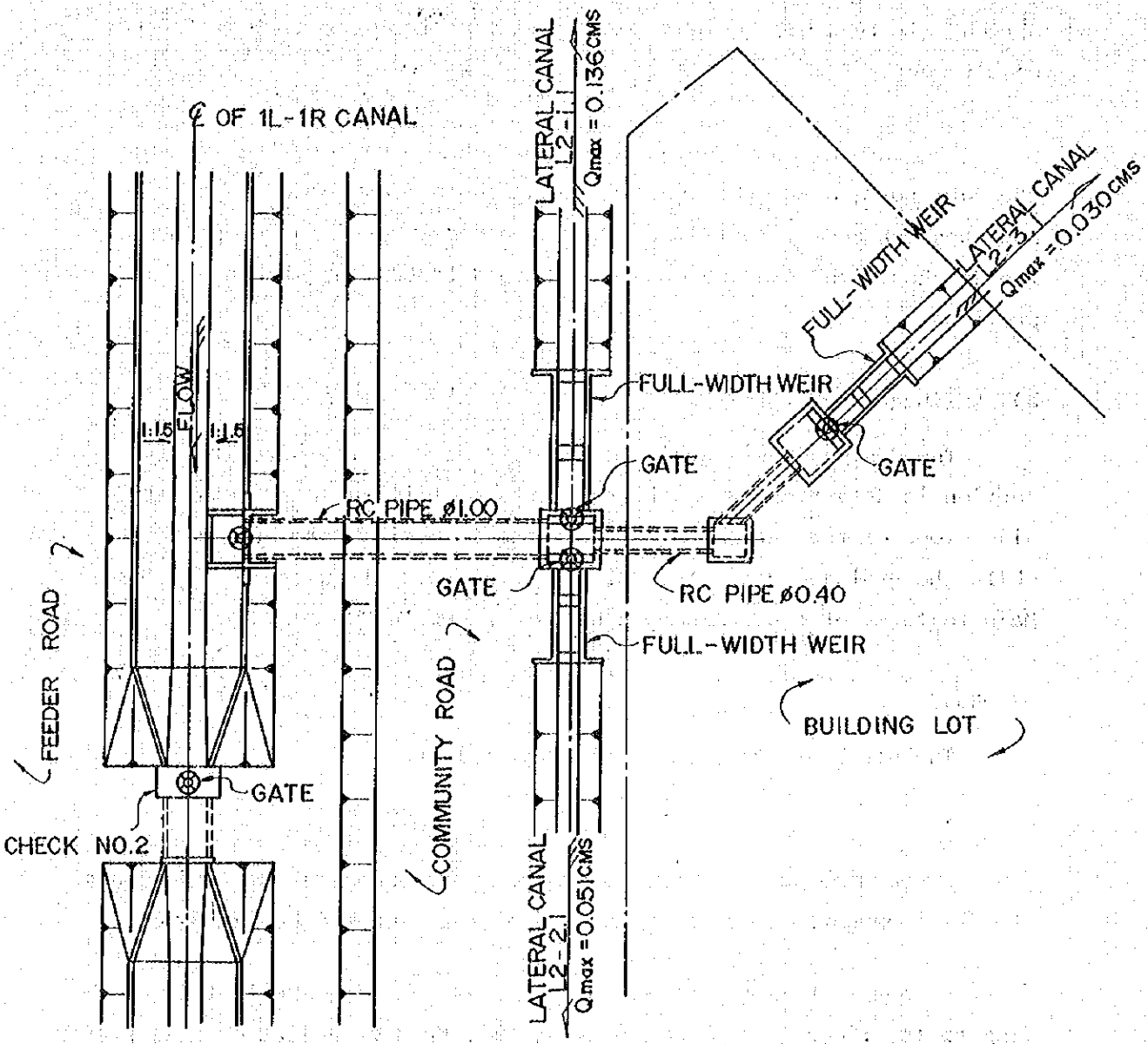


FIGURE 3-8 PLAN OF INTAKE NO.2



iii) Other facilities

Turnouts to be installed along the lateral canals shall provide such structures that can possibly minimize the head loss. As the water will be diverted through turnouts in constant quantity, the submerged weir type will be able to function satisfactorily to meet the requirement.

The farming machineries will approach to the farm fields from the farm road, along the one side of which the farm ditch is provided, and then the access facilities should be constructed to bridge over the ditches with reinforced concrete pipes (ø300 m/m) should be provided.

b) Drainage Facilities

The designed unit drainage quantity is 5.01 l/s/ha. The cross-section is determined with the roughness coefficient of 0.040. The side slope of the lateral drainage canal is designed to be 1:1.5, while the drainage ditch to be 1:1.0 owing to shallow depth of 1.0 m. Main features of the drainage canal are shown in DWG.M1-7.

c) Road

The width of roads was decided as follows:

	Total Width	Remarks
Farm-roads:	3.0 m	Tractor or T-9 ton trucks passable
Community roads:	4.0 m	T-20 ton trucks passable

Although the lower road surface elevation is convenient in accessing to the fields, it should be elevated, from viewpoint of soil properties and O & M, at least 0.1 m above the water level in the ditches along the farm roads. The elevation of farm roads should be 0.3 m above the field surface, and the community roads should have 0.5 m height.

The loads to farm road by vehicles used in the Project Area is restricted to less than T-9 ton. The vehicles available in the area would be trucks with five ton load at maximum, accordingly. Furthermore, it should be noted that the heavy construction machinery will be prohibited in operation after installation of the irrigation pipes in the farm road.

The culvert of reinforced concrete pipes should be installed at least with an earth covering depth of 0.3m under the on-farm road and 0.5 m under the community road.

d) Land Levelling

On levelling lands, the margin of errors with $\pm$5 cm will be permissible. In the Project, the unit plot is so large by 160 m x 50 m that a great care should be exercised in levelling works. Partial unevenness in the plots will be re-levelled when plowing and puddling are carried out after land consolidation completed.

For some time after completion of the Project, to provide temporary irrigation ditches along ridges will be effective for correct and speedy water control. In the same manner, temporary drainage ditches in the fields will well function for quick drying the paddy fields.

The calculation of earth quantity of land levelling was made with the electric computer, reading the mesh data of spot elevation at an interval of every 40 m, indicated on the topograph maps scaled 1/4,000.

The designed ground elevation of each farm plot is shown in DWG.M 1-2. TABLE 3-6 shows the results of the calculation.

TABLE 3-6. Summary of Earth Moving

Irrigation Block (ha)	Earth Volume (cu.m/ha)	Hauling Distance (m)
No.1 64.3	422	106
No.2 71.1	162	105
No.3 76.6	159	95
No.4 109.4	271	91
No.5 40.7	541	116
Average	283	102

3-3. No. 2 Pilot Project

3-3-1. Farm Management Program

a) Land Use

The proposed land use was determined on the basis of paddy double cropping and diversification of crops. The high yielding varieties (HYV) of paddy with short stems (RD strains) shall be cropped for the paddy growing; however, some paddy fields may be submerged deep in the wet season because of the plot-to-plot irrigation, and in such deep water fields the photo sensitive varieties will be grown in the wet season. In the No. 2 Pilot Project, no large-scale land levelling will be carried out, whereas the water supply conditions to the high-lying lands will be remarkably improved with the irrigation system provided effectively.

TABLE 3-7. Proposed Land Use (No. 2 Area)

(Unit: ha)

Land Category	Present	Proposed
Cultivated lands	534.2	504.0
Paddy field	511.2	481.9
Upland field	2.0	2.0
Sugarcane	21.0	20.1
Roads, Canals	28.0	58.2
Homestead	1.0	1.0
Total	563.2	563.2

NOTE: Land deduction rate = (534.2 - 504)/534.2
= 5.7%

b) Proposed Cropping Pattern

Mainly, the paddy double cropping will be introduced in the Project. In the dry season, the HYV will be cropped in the total area and in the wet season, the HYV for some parts and the conventional varieties for the others will be cropped. The conventional varieties, the photosensitive varieties, should be transplanted up to the end of September at the latest so that the harvesting can be finished end of November through middle of the following January.

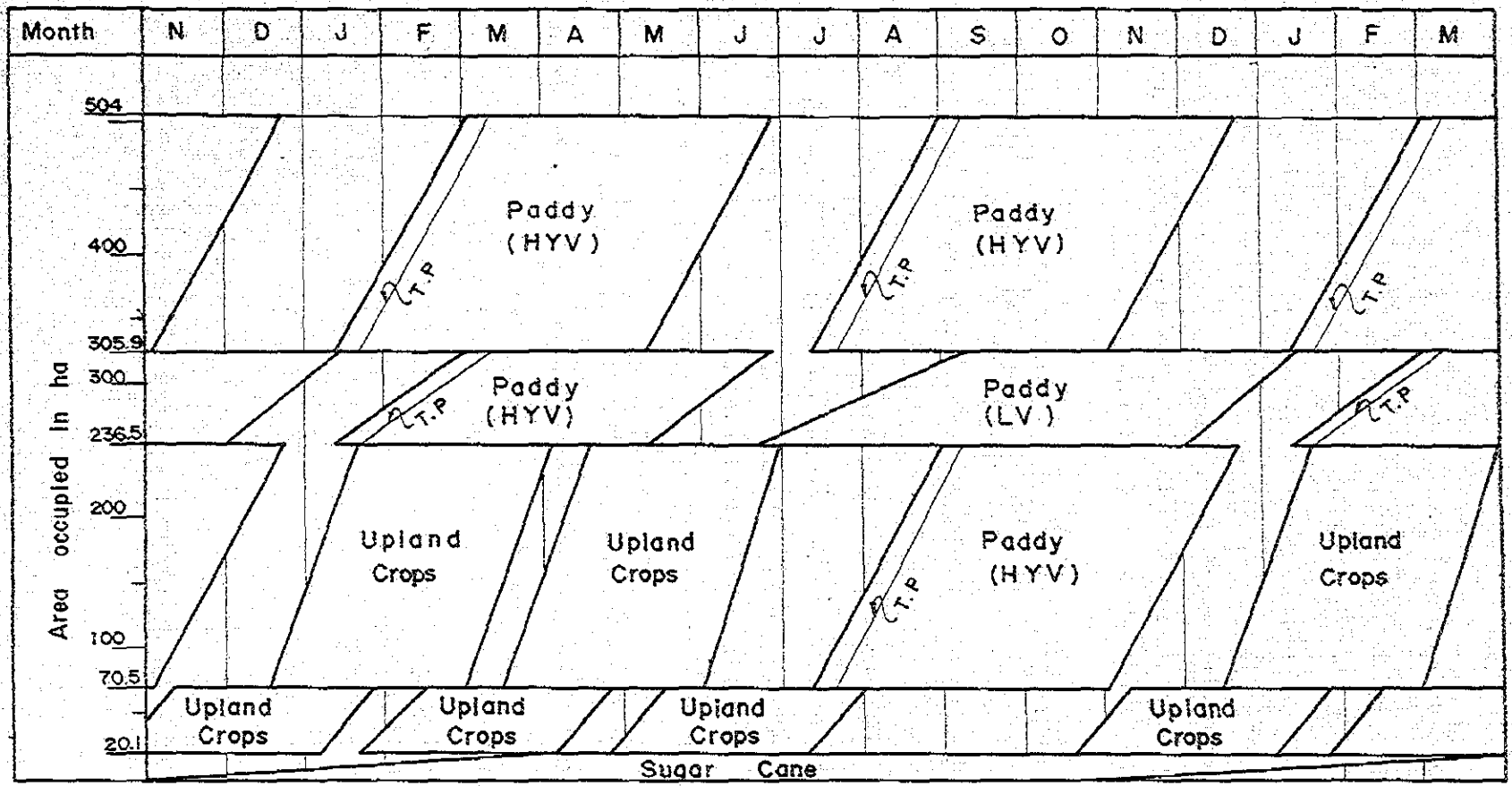
The HYV of RD strain, bred in Thailand, will be introduced with prospect to grow in a period of 125 days in the wet season and 130 days in the dry season. FIGURE 3-9 shows the proposed cropping pattern.

c) Labor Requirement and Agricultural Production

It is expected that the agricultural production of the No. 2 Project Area will reach the levels as listed in TABLE 3-6 when the irrigation and drainage systems are completely built up with the adaptation of the advanced technology developed in the trial farm and model farms.

FIGURE 3-10 shows the monthly farm labor requirements estimated according to the Proposed Cropping Pattern. From this figure, it is evidently understandable that the labor force available in the individual farms (3 persons/farm) is far less than is required during almost half a year.

FIGURE 3-9 PROPOSED CROPPING PATTERN (NO.2 AREA)

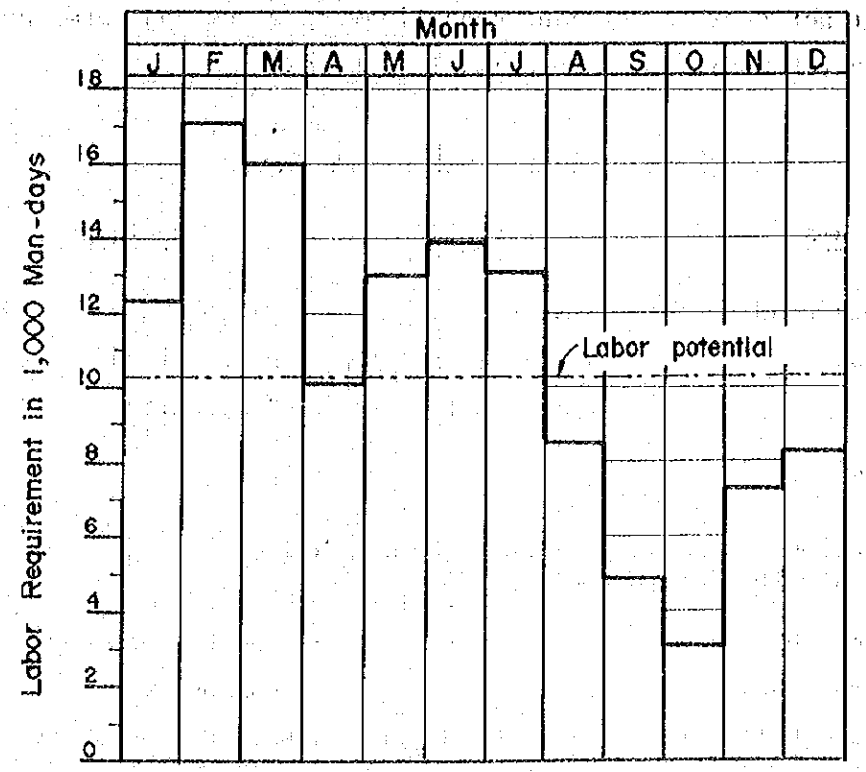


Notes : HYV = High Yielding Varieties , LV = Local Varieties
T.P = Transplanting

TABLE 3-8. Target Production (No. 1 Area)

Crops	Target Production Acreage (ha)	Yield (t/ha)	Production (t)	Increased Production (t)
Paddy				
Wet season HYV	354.1	3.5	1,274	1,274
Dry season HYV	247.8	4.0	991	991
Wet season LV	69.4	2.8	194	- 883
Total			2,459	1,382
Pulse	2x92.9	1.6	297	276
Vegetables	2x92.8	12.9	2,394	2,394
Upland crops				
Pulse	3x25.2	1.6	121	121
Vegetables	3x25.2	12.9	975	973
Sugarcane	20.1	80.0	1,608	558

FIGURE 3-10 PROPOSED FARM LABOR REQUIREMENT (NO.2 APEA)



3-3-2. Agricultural Infrastructure Consolidation

The extensive land consolidation plan for the No. 2 Area is formulated as shown in FIGURE 3-11. The main difference of the extensive method from the intensive one is that though implemented in the intensive land consolidation, land levelling and land reallocation are hardly implemented in the extensive land consolidation. Accordingly, the present land borders will be left untouched, and the construction costs by the extensive method will be reduced to about 37% of that by the intensive method.

In the extensive land consolidation, the water control with lower accuracy is unavoidable, furthermore, the level of farm mechanization will be limited to some extent. However, the improvement of canal systems and construction of farm road networks will bring the Area much more farm production and better working conditions than those at the present.

The density of the proposed roads and canals per hectare, the estimated cost per hectare for land consolidation works and farm land reduction rate for public use are summarized below.

Density of road and canal (m/ha)

Road		Irrigation		Drainage	
Community road	11	Lateral	16	Lateral	19
Farm road	44	Farm ditch	43	Drain ditch	34
		Minor ditch	45	Minor ditch	19
Total	55		104		72

Construction cost: 1,245 ฿/rai (389 US$/ha)
Reduction rate of farm land: 5.7%

The rather high land reduction rates are caused by the construction of the leading drainage canals along the community roads proposed to make better use of the borrow-pits along the community roads.

a) Irrigation

In the irrigation systems of the Area, irrigation water is led from the lateral canals to the farm ditches in the same manner as for the No. 1 Pilot project area. However, the plot-to-plot irrigation is inevitable in some areas as each farm plot does not always face to the farm ditch. Thus, the construction of additional minor ditches is proposed so that the plot-to-plot irrigation within 3 to 4 farm plots is possible. Most of the existing ditches will be used as a minor ditch.

i) Peak irrigation requirement

FIGURE 3-12 shows the estimated annual irrigation schedule on the basis of average year. The peak irrigation requirements will occur twice a year in the latter half of the wet season (October) and in March of the dry season. The peak irrigation requirement to determine the canal capacity will occur in the last day of puddling periods for dry season paddy cropping, and is designed as shown below.

Water requirement: 6.99 mm/day or 0.809 l/sec/ha
Diversion requirement: 7.77 mm/day or 0.899 l/sec/ha

The designed capacities of lateral canals and farm ditches are listed below.

Canal	Irrigation Block No.	Irrigation Block Ha.	Capacity (cu.m/s)
Lateral	1	69.2	0.060
	2	61.2	0.046
	3	49.5	0.048
	4	74.7	0.066
	5	23.7	0.023
	6	9.7	0.009
	7	63.2	0.061
	8	47.9	0.044
	9	16.3	0.015
	10	32.1	0.031
	11	70.1	0.059
	12	19.1	0.018
	13	65.3	0.061
	Total	602.0	0.541
Ditch	-	19.2	0.024

b) Drainage

The drainage area covers not only the Pilot Project Area but also the populated village areas located in the southeast of the Area. The Project Area is divided into 11 drainage blocks, of which 9 blocks belong to the Tha Sarn drainage system and 2 blocks to the Tha Sarn Bang Pla 10 RD drainage system. The designed drainage capacity of each block is listed below.

Drainage Block	Drainage Area (ha)			Capacity (cu.m/s)
	Paddy Field	Others	Total	
1	49.7	-	76.3	0.543
2	44.6	-	54.4	0.327
3	21.3	-	26.2	0.160
4	100.8	-	224.5	1.918
5	56.9	-	67.7	0.387
6	37.9	-	51.2	0.329
7	109.9	-	215.6	1.774
8	28.9	-	36.8	0.237
9	44.6	-	75.5	0.596
10	17.3	-	21.1	0.128
11	56.4	-	69.3	0.409
Total	568.3	-	918.6	6.808

c) Irrigation and Drainage System

The Project Area slopes to the north at a gradient of 1/1,000-1/3,000, except for the area along the Left Main canal having a slope of about 1/2,000 to the south.

In the planning of the irrigation and drainage systems, particular consideration was given to the following:

(1) To utilize the existing facilities as far as possible

- Use of check and diversion facilities of the 3L canal
- Use of the existing ditches as a minor ditch
- Use of the borrow-pits for the 3L canal as a drainage canal.

(2) To shorten the length of the irrigation canals as far as possible as the canals are of earth canal.

(3) To keep the water level in the canal constant for better water control by installing the check device.

The consideration leads to use of all check devices of the 3L canal and turning the borrow-pits (6.8 km in length) to practical use as drainage canals. About 60% of the existing ditches will be used as a minor ditch.

d) On-farm Land Development

The extensive method, as mentioned already, is applied to the on-farm land development of the Area, and levelling and reallocation of land will not be implemented except a special case. Careful examination, therefore, shall be made of the topographic condition of the Area.

Irrigation unit. A farm block to be commanded by one farm ditch and its minor ditches is termed an irrigation unit, and is corresponding to an irrigation rotation block. Though desirable for better water control and farming practice, establishment of uniformed shape of irrigation units is hardly expected in the Area owing to application of the extensive method.

The proposed irrigation units are designed to have around 19 ha of farm plots each and all, and one irrigation unit is composed of 6 irrigation units, considering the topographic and water use conditions.

Road. Two kinds of road, namely on-farm road and community road, are proposed. The on-farm roads will be constructed at an interval of about 320 m and the community roads will be constructed to cross the on-farm road with a right angle at an interval of about 600 m.

The embankment materials for the roads will be excavated at one side of each proposed road and the borrow-pit shall be used as a

drainage canal. On the other side of the road, the farm ditch will be constructed.

Three farm inlets to give access to the farm plot, three farm inlets will be installed on each farm ditch at an interval of about 150 m. The farm inlets will also function as a check device of the water level in the farm ditch.

Canal. Along the roads, any type of canal will be provided. The canal net is almost the same in principal as that of the No. 1 Project Area. Borrow pits excavated when road is constructed are used as drainage canals. Consequently, the size of drainage canal is mostly determined based on the required amount of earth for road embankment rather than hydraulic advantage. The minor ditches will be provided in the Area where plot-to-plot irrigation is applied, as mentioned above.

e) Water Management

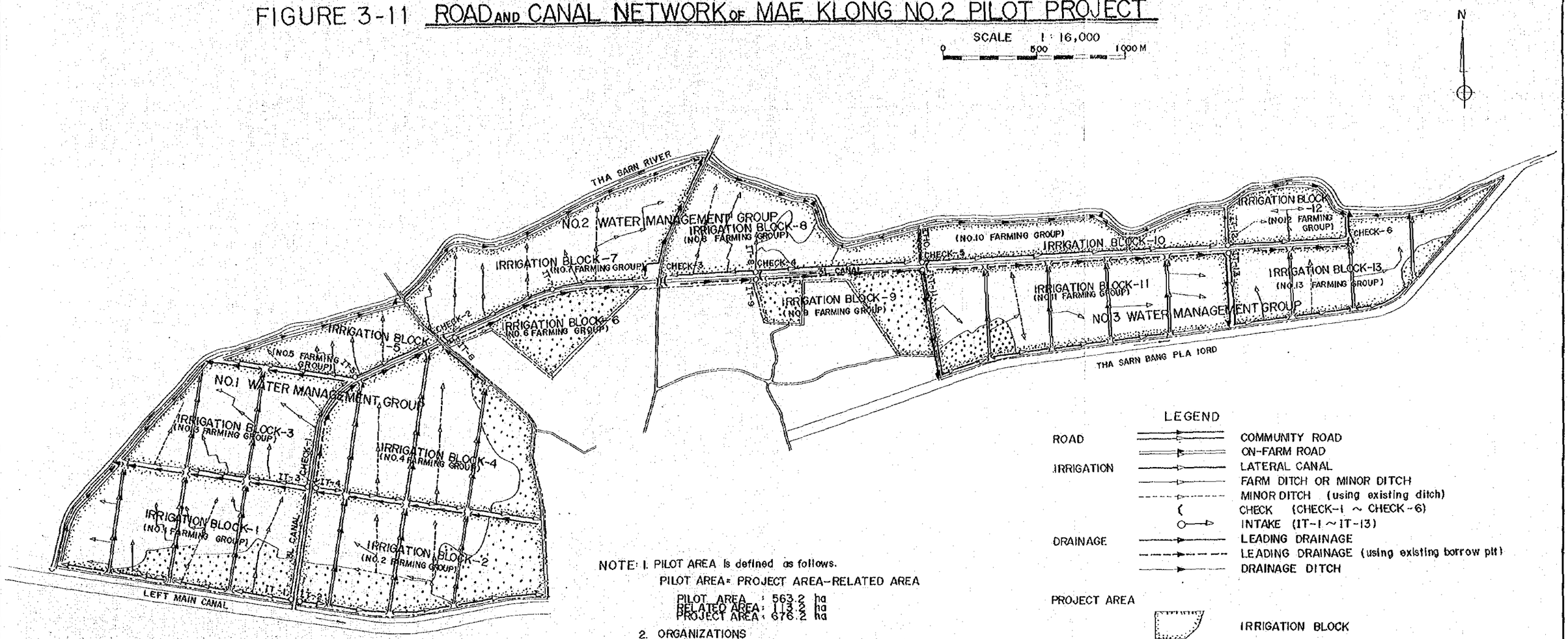
In the No. 2 Area with the extensive land consolidation works, one of the most important factors on which the success of the Project largely depends is water control, while in the No. 1 Project Area, planning is elaborately made to facilitate water control.

Water control system of the No. 2 Project Area consists of the following three sub-systems, which is the same as No. 1 Project Area:

Sub-system	Facilities
Intake sub-system	3L canal, check, intake
Conveyance sub-system	Lateral canal, check, diversion
Distribution sub-system	Farm ditch, minor ditch, farm inlet

In the No. 2 Project Area, 3 water management groups and 13 farming groups will be organized to rationally control water.

FIGURE 3-11 ROAD AND CANAL NETWORK OF MAE KLONG NO.2 PILOT PROJECT



NOTE: 1. PILOT AREA is defined as follows.

PILOT AREA = PROJECT AREA - RELATED AREA

PILOT AREA	: 563.2 ha
RELATED AREA	: 113.2 ha
PROJECT AREA	: 676.2 ha

2. ORGANIZATIONS

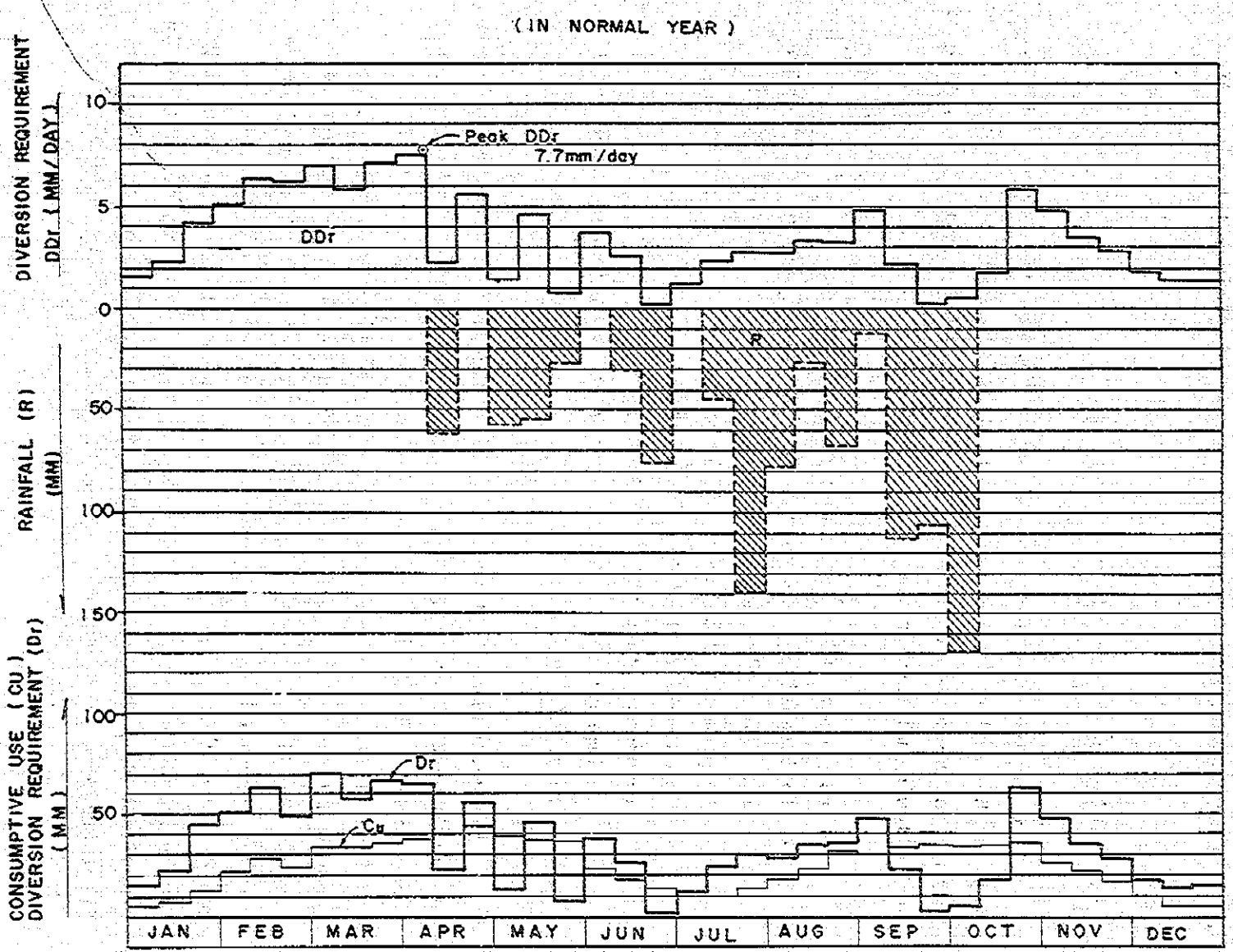
FARMING GROUP: Project consists of 13 farming groups.

WATER MANAGEMENT GROUP: Project consists of 3 water management groups.

LEGEND

ROAD	COMMUNITY ROAD
	ON-FARM ROAD
IRRIGATION	LATERAL CANAL
	FARM DITCH OR MINOR DITCH
	MINOR DITCH (using existing ditch)
	CHECK (CHECK-1 ~ CHECK-6)
	INTAKE (IT-1 ~ IT-13)
DRAINAGE	LEADING DRAINAGE
	LEADING DRAINAGE (using existing borrow pit)
	DRAINAGE DITCH
PROJECT AREA	
	IRRIGATION BLOCK
	RELATED AREA (water supply is only scheduled)
	BOUNDARY OF WATER MANAGEMENT GROUP

FIGURE 3-12 ANNUAL IRRIGATION SCHEDULE IN NO.2 PILOT PROJECT



The number of the farming groups are large in comparison with the coverage, due to the rather narrow and long shape of the Area. Water will be controlled in the same manner as the No. 1 Project Area does.

3-4. Agricultural Supporting Services

The improvement of the agricultural supporting services aims to provide the conditions for establishment of the high productivity agriculture on the consolidated infrastructure. The Project will deal with the following matters in the related field:

- to promote the land consolidation project,
- to intensively extend the farming techniques and strengthen the farmers' training,
- to promote organizing the farmers,
- to establish the marketing system,
- to promote farm mechanization, and
- to improve the crediting system and promote accumulation of farmers' own capital.

The governmental officials in charge, who will receive training in the Suphanburi Training Center, shall be responsible to carry out these works. In the No. 1 Pilot Project involving about 400 ha of the Project Area, agricultural supporting services will be rendered through activities in the trial farm and the model farms in utilizing various facilities. In the No. 2 Pilot Project, no trial farm nor model farm are provided and the Changwat level extension officers or the cooperative staff in charge shall be reponsible to give guidance to the farmers, and the experts serving in the No. 1 Pilot Project will be in a position to give advices and guidance to the farmers in the No. 2 Pilot Project, if necessity arises.

3-4-1. Trial Farm

The trial farm will be provided with about 10 ha along IL-1R canal in the No. 1 Pilot Project Area. The trial farm will be used for the applicability test of improved farming techniques and giving training to the farmers.

a) Applicability Test

The following items will be studied in the trial farm by experts of irrigation/drainage, agriculture, farming machine, water management, agricultural extension services and others concerned.

1) Plowing and puddling
2) Land levelling
3) Weed control
4) Nursery of seedlings for transplanting machine
5) Application of transplanting machine
6) Application of harvester
7) Pest control
8) Rodent control
9) Comparative test of varieties
10) Bearable capacity of land
11) Water management
12) Surface soil treatment
13) Upland irrigation
14) Fertilizer responsiveness
15) Soil improvement
16) Rotational cropping system

The tests and trials mentioned above should be carried out for the practical purpose, based on the results obtained by the Suphanburi Rice Experiment Station and many other existing data. It will be required to have close relationship among test items, although the agronomist, agricultural expert, will place the main target of these tests.

b) Training

Those lecturers who will be trained in the Suphanburi Training Center will give training to the farmers selected among those in every district. These trainees should be preferentially selected from those farmers whose farm lands will be land-consolidated.

The training covers lectures and exercises and should be held in the slack time of the farming works so that the farmers can participate conveniently. A consideration should be paid to avoiding long lectures.

The following are the main training items: 1) Water management, 2) Preparation for establishment of agricultural cooperatives, 3) Management of farming groups, 4) Mechanization of farming and 5) Farm maintenance such as fertilization, pest control, weed control, etc. A course of training takes 10 days and a half-day training will be responsible. Among the trainees, the farmers in the No. 1 Pilot Project Area, who get the fair show, shall be designated as model farmers.

3-4-2. Model Farm

The model farm in the No. 1 Pilot Project will provide the necessary input materials and farming machines to demonstrate the new farming techniques. The selected model farmers will be trained intensively on the know-how of new farming by the experts assigned to services in the trial farm. The agronomist and agro-economist should conduct a tracing survey on changes of farmers' income and living standard in the model farm for the confirmation of project impact.

In the Project Area, three model farms (three farmers) should be selected to study the following matters on farm operation:

1) Application of improved techniques to the farmers' own fields,
2) Demonstration of improved techniques, and,
3) Seed farm for renewal.

a) Selection of Model Farmers

In principle, the model farmers shall be selected among those who have enthusiasm for agriculture, and it is essential to make a definitely fair selection in considering those selected farmers may enjoy various favors and conveniences. The selection standard shall be provided as follows:

1) Education level of householder: At least graduated from the primary school.
2) Liabilities: Not exceeding the gross annual income.
3) Labor availability: Reserving average labor force for farming works to be required.
4) Training: Having participated in the training in the trial farm.

b) Management of Model Farm

The farmers belonging to model farm shall submit the annual schedules for cropping and management of their farms to have approval from the related experts and have supply of the necessary input materials. Fertilizers and other agri-chemicals will be furnished with the same quantity as the other farmers through farmers' organization to be established in the Project.

In the early stage of the Project, the possession and operation of farming machines will be controlled by the preparatory agricultural cooperatives. In this way, the farmers will use the machines for their works on the rental basis, without any much funds for purchase and risks for their operation and maintenance.

The operation ratio of the machines may be comparatively low because many and unspecified farmers will use them. Therefore, there will be various problems on operation of those machines by the preparatory cooperatives. Under the situation, the farm mechanization in the early stage shall aim to give farmers the information and understanding on the mechanized farming through the cooperatives' activities.

The farming machines shall be rented to the model farmers with the reasonable charges. It will be necessary to give various favors, long-term low interest credit, installment system for machine purchase, to those farmers who want to have their own machines; these favors should be provided along with the policy of the Project. Furthermore, when the model farmers may help other farmers in the Project Area in their appropriation of the machines after finishing their own works, so as to make the machine operation more effective.

3-4-3. Program of Farmers' Organization

There exists no powerful farmers' organization in both No. 1 and No. 2 Pilot Project Areas. The Projects include a plan to form new farmers' organizations in the Areas. For the time being, the Department of Cooperatives Promotion will take initiative to form the organization along with its own policy and have to supply necessary funds and experienced personnel for establishment and operation of such organizations.

Agricultural Cooperatives. There shall be the agricultural cooperatives organized, through which modernized farm management and improved farming techniques will be diffused for successful implementation. The Pilot Project Areas, since having small scales, seem to have difficulty to provide well-managed independent agricultural cooperatives, and a temporary cooperatives, calling Preparatory Agricultural Cooperatives shall be organized.

The Department of Cooperatives Promotion will assign cooperative officer to the temporary cooperatives as directors. Several local government officers in Changwat level or Amphoe level shall be appointed to the main staff of the cooperatives, who should receive the guidance and training in the Federation of Agricultural Cooperatives, Thailand, Bangkok.

The Extension Expert to cooperate with the directors of the preparatory cooperatives to strengthen the organization and to give proper

training to the related staff on the basis of adequately prepared training schedule.

The main purposes of the preparatory cooperatives are as follows:

- to smoothly promote the land consolidation works,
- to run a rational water management,
- to amply supply farming inputs and rationalize collection, storage, processing and marketing of the proudcts,
- to establish measures for promotion of farm mechanization, including operation and maintenance of the machines,
- to give farmers the training and guidance on improved farming techniques,
- to give credit to farmers, and
- to try to level up the farmers economy. (cash deposit and accumulation of self-capital)

In a period of five years of this Technical Assistance, however, the training and education of the farmers will be given in the trial farm of No. 1 Pilot Project only. In this technical assistance, also, the land consolidation works in the No. 1 Pilot Project Area will be implemented from the second project year to the fourth, and those in the No. 2 Pilot Project from the fourth project year to the fifth project year. Under the program, the ultimate goal of production will not be accomplished within the assistance period of time. The preparatory agricultural cooperatives activities will focus on the land consolidation works in the early part of the Project works. The water management, collective works, introduction of the dry season paddy cropping, etc., will be implemented in one farm plot after another where the land consolidation works will have been completed.

The preparatory agricultural cooperatives will provide farmers' groups, the sub-organization. Furthermore, the organizations of water management and farm mechanization will be required for early accomplishment of the Project target. In the No. 2 Pilot Project, unfavorable

field conditions restrict the introduction of large-size farming machines, and small-size machines will be employed for the part mechanization of farming in a short-ranged program of implementation. The above organization will be involved in the agricultural cooperatives for their effective services.

Farming Groups. The size of farming groups shall accord with that of water management group, and five farming groups shall be in the No. 1 Pilot Project Area, and four farming groups in the No. 2 Pilot Project Area, respectively. The farming groups will be responsible to perform the following works:

- to prepare the cropping program,
- to prepare the programs for irrigation and water management,
- to prepare the program for collective farming works and to implement the program (nursery bed, transplanting, pest control, mechanized farming, etc.),
- to carry out collective forwarding of the products and marketing, and,
- to carry out collective purchasing of input materials.

Water Management Organization. For the more effective water use by newly introduced rotational irrigation, the water management groups shall be organized to prepare the water management work schedule, and to carry out operation and maintenance of water control facilities. It is proposed to organize five groups in the No. 1 Pilot Project Area and four groups in the No. 2 Pilot Project Area along with the schedule.

The water management groups shall prepare the related work schedule based on the cropping program prepared by the farming groups and control the water in cooperation with the zonemen that will be designated by the RID.

Farm Mechanization Organization. When introducing mechanized farming to the Pilot Project Areas where farmers have only poor knowledge and experience about machine application to the farming, guidances on specific cropping method by machines and forming and operating farmers' groups for successful implementation of mechanized farming will be indispensably provided, particularly in the No. 1 Pilot Project Area, on top of the ordinary technical guidance and maintenance services of the machines, etc.

In the first stage of mechanization, mechanized farming will be exercised only in the trial farm for machine applicability test and in the demonstration farm for demonstration of machine operation under intensified guidance by the experts.

It is proposed the preparatory agricultural cooperatives shall possess the machines and operate them in the early stage of the development; however, the farmers groups should be organized for more extensive and effective use of machines in the very near future. Since the No. 1 Pilot Project Area, where the land consolidation will be completely implemented, will provide sufficient conditions to meet the requirements for mechanized farming, the farmers organization for mechanized farming should be formed by related farmers on the land cadastral basis.

TABLE 3-9. List of Infra-facilities in Mae Klong No.1 Pilot Project

Infra-facilities	Unit	Construction Year 1st Year (1978)	2nd Year (1979)	3rd Year (1980)	Total
Road					
Community Road	m	2,544	5,331	2,436	10,311
On-farm Road	m	2,280	5,461	4,800	12,541
Total		4,824	10,792	7,236	22,852
Irrigation Canal					
Lateral Canal	m	1,943	4,600	2,304	8,847
Farm Ditch	m	2,462	6,061	4,800	13,323
Total		4,405	10,661	7,104	22,170
Drainage Canal					
Leading Drainage	m	-	3,494	2,479	5,973
Drainage ditch	m	2,962	5,430	5,255	13,647
Total		2,962	8,924	7,734	19,620
Irrigation Structures					
Intake	Places	1	1	-	2
Check Gate	-do-	1	1	-	2
Bridge	-do-	1	1	-	2
Diversion Box	-do-	1	1	-	2
Irrigation Culvert	-do-	9	12	6	27
Turn Out	-do-	3	10	8	21
Inlet	-do-	7	48	46	101
Tail Waste	-do-	4	10	8	22
Farm Inlet	-do-	24	55	48	127
Drainage Structures					
Drainage Culvert	Places	5	14	9	28

TABLE 3-10. List of Infra-facilities in Mae Klong No.2 Pilot Project

Infra-structures	Unit	Construction Year: 1st Year (1980) Project Area	1st Year (1980) Related Area	1st Year (1980) Total	2nd Year (1981) Project Area	2nd Year (1981) Related Area	2nd Year (1981) Total	Total Project Area	Total Related Area	Total Total
Road										
Community Road	m	5,370	440	5,810	450	140	590	5,820	580	6,400
On-farm Road	m	9,690	1,490	11,180	15,230	-	15,230	24,920	1,490	26,410
Total		15,060	1,930	16,990	15,680	140	15,820	30,740	2,070	32,810
Irrigation Canal										
Lateral Canal	m	5,370	440	5,810	3,850	140	3,990	9,220	580	9,800
Farm Ditch	m	9,690	1,490	11,180	14,785	-	14,785	24,470	1,490	25,960
Minor Ditch	m	9,580	-	9,580	13,100	-	13,100	22,680	-	22,680
Total		24,640	1,930	26,570	31,735	140	31,875	56,370	2,070	58,440
Drainage Canal										
Leading Drainage	m	4,470	440	4,910	6,230	140	6,370	10,700	580	11,280
Drainage Ditch	m	8,430	1,270	9,700	10,670	-	10,670	19,100	1,270	20,370
Minor Ditch	m	4,045	-	4,045	5,530	-	5,530	9,575	-	9,575
Total		16,945	1,710	18,655	22,430	140	22,570	39,375	1,850	41,225
Irrigation Structures										
Check Gate	Places	2	-	2	4	-	4	6	-	6
Intake	-do-	5	-	5	6	2	8	11	2	13
Turnout	-do-	18	-	18	16	-	16	34	-	34
Irrigation Culvert	-do-	13	-	13	12	-	12	25	-	25
Farm Inlet	-do-	39	-	39	38	-	38	77	-	77
Minor Check	-do-	35	-	35	65	-	65	100	-	100
Drainage Structures										
Drainage Culvert	Places	28	-	28	22	-	22	50	-	50
Minor Culvert	-do-	7	-	7	15	-	15	22	-	22
Waste Way	-do-	3	-	3	4	-	4	7	-	7
Drainage Regulator	-do-	-	-	-	1	1	2	1	1	2

CHAPTER 4. ARCHITECTURAL FACILITIES

The implementation of the technical cooperation project in the Mae Klong Pilot Project Area will require to provide the following facilities, such as temporary field office, project office, experts' lodging and facilities for the trial farm. After the discussion on the field office, project office and experts' lodging, the Mae Klong Irrigation Project Office and the Survey Team achieved the following mutual agreement:

- The office of the Mae Klong Pilot Project will be established in the compounds of the Mae Klong Irrigation Project Office.
- Part of the architectural facilities of the Mae Klong Irrigation Project Office will be offered to the Pilot Project, and additional buildings or facilities, when necessity arises, will be built at the site possessed by the Mae Klong Irrigation Office.
- Part of accommodations in the Mae Klong Irrigation Project Office will be exclusively used as experts' lodging.

4-1. Outline of the Proposed Facilities

Management Office. The management office is a nucleus of the trial farm providing office rooms, conference rooms, lecture rooms for farmers, and laboratory. The related experts and Thai officers to be assigned in the office will be 5-6 and 10-12 persons, respectively, and the farmer trainees will be 10-20 persons; then the scale of the facilities was designed in reference to the above figures.

Workshops. The trial farm will provide four workshops such as a general workshop, a threshing house, a milling house, and a repair-shop.

Sheds. Two sheds will be provided to house tractors, combine harvesters, rice planters, etc. and one garage to house trucks and a light-van.

Warehouse. The following warehouses will be constructed for various purposes:

- Rice warehouse equipped with airconditioned room for rice storage test available.
- Warehouse for farming implements including fertilizers, agri-chemicals.
- Warehouse for general use.
- Warehouse for fuel oil and others.

Shower room and lavatory. The independent buildings for shower and lavatory will be constructed for the trainees and the laborers in the trial farm.

Canteen. For the convenience of taking lunch, and rest, a Thia-style arbor will be constructed and utilized by laborers, trainees, Thai officers and Japanese experts. Such facilities will provide an opportunity to promote friendly relation and mutual understanding among the people concerned.

Others. The miniatured Buddhism temple, so-called "Sangapoung" in Thai will be placed in a corner of the garden near the entrance, subjected to the custom of the Country. Furthermore, a instrument shelter for weather observation, paddy drying yard, working yard are planned to be provided.

The buildings to be constructed in the trial farm are listed below.

Name	Floor Area (sq.m)	Remarks
Management office	512	including 170 sq.m. of terrace and corridor
Rice warehouse	60	airconditioners equipped
Threshing house	147	
Rice mill	147	serving dually as hulling plant

Name	Floor Area (sq.m)	Remarks
General workshop	147	
Repairshop	147	
Agri. machinery shed	294	147 sq.m x 2
Garage	147	
Agr. instruments warehouse	147	
General warehouse	147	
Oil & fuel storage	21	
Canteen	100	
Shower+W.C.	45	
Total	2,061 sq. m.	

4-2. Layout

4-2-1. Location

The location of the building lots are determined, where is easy access and most preferable to replot the farm blocks of the adjacent farm lands. The selected lots with the area of about 22,500 sq.m. is located near the Station No. 7K + 500 along the IR-IL canal. The existing road along the IR-IL Canal permits easy access to the buildings and facilities planned.

4-2-2. Layout of Buildings

Every building and facilities, having its own purpose and function, should be laid out to function as a whole to meet the Project requirements in keeping good interrelation among each other. In layout of these facilities, there will be three approaches as follows:

a) Each facility have its own building independently.
b) Several facilities with similar nature are housed in one building to make function-wise groups of buildings.
c) All facilities are housed in one large building which provides several interior blocks by facilities.

In case of b) above, although working flexibility may be available, the flow paths of work is apt to be confused and the good arrangement is difficult for materials, equipment and other articles. And the case c) should not be applied except for necessity requiring for two or three stories buildings due to insufficient construction site reserved or specially for only one building needed in the design aspect.

In the Project, the case a) was adopted in considering the sufficient space available for buildings and simplicity of the construction works. In the lay-out of this case a), it is essential to place every building to make its function fully effective under organic interrelation in each other.

4-2-3. Creation of Necessary Building Lots

The building lots should be embanked up to EL 21.2 m which should be taken as the standard elevation of the street gutters. The elevation of road center and surroundings of the buildings is designed a little higher than EL 21.2 m with two to four percent of gradient to assure good drainage.

Roads parking and car washing area are to be paved with asphalt after compaction of 15 cm thick laterite and 5 cm thick sand. Gardens will be turfed, and flower beds and tree planting will be made partially. The proposed land use of facilities lots is shown below:

Facilities	sq.m.
Building (Roof-projected area)	2,980
Road, parking area	4,660
Work yard	1,310
Garden	12,300
Canal, others	1,290
Total	22,540

4-3. Supply and Disposal

4-3-1. Electric Power Supply

The electric power will be supplied from the distribution facilities at the pumping station for IL-1R canal (STA. 0). The power consumption is estimated as shown below.

Facilities	KVA	Facilities	KVA
Management office	15.6	Garage	0.3
Threshing house	9.0	Fuel and oil storage (for lighting)	1.0
Rice mill	9.0		
General warehouse	9.0	Shower room, lavatory	0.6
Rice warehouse	3.3	Canteen	1.8
Repair shop	15.0	Out-door lighting (13)	3.3
Shed (I)	0.3	Pumps	
Shed (II)	0.3	Well pump	11.0
Agri-instruments warehouse	0.3	Garden pump	6.2
		Total	86.0

Power transmission. The source voltage and distribution system shall be discussed and determined after necessary surveys are made. It is estimated that the power line extend to 7.2 km and about 80 poles (at interval of 80 m) are installed for the line.

Substation. In order to lead the power source in the trial farm, one incoming unit of 380V, three phase, 4 wires, will be required.

Distribution. Power lines extending about 550 m and 17 of wooden poles (30 m intervals) will be required.

4-3-2. Water Supply

The necessary water will be supplied by pumping up of the groundwater. The groundwater pumped-up will be stored in a storage tank at first, and distributed to each facility by a pressure delivery system. However, since detailed surveys on water quality, quantity and so on

were not carried out, the proposed water supply system is subject to change in accordance with the surveys to be succeeded.

The capacity of daily water supply is as shown below.

Facilities	l/day
Management office	2,000
Canteen	1,500
Shower room, lavatory	2,000
Car washing area	1,000
Outdoor water plugs	900
Total	7,400

Daily water consumption: 7,400 l.
Average hourly water consumption: 925 l.
Max. hourly water consumption: 1,800 l.
Momentary max. consumption: 440 l/min.

Well pump

Capacity	50 l/min. (Filling-up the tank within 2.5 hours)
Bore diameter	32 m/m
Total head	35 m (Assuming the depth of well to be 30 m)
Power consumption	1.1 KW
Pump type	Submerged multi-stag type (15 stages)
Well diameter	125 m/m

Water tank

Capacity	7,400 l (equivalent to the sum of daily consumption)
Materials & structures	Reinforced concrete (20 m × 4 m × 1.5 m)

Pressure water supply system. Two units of pressure water supply systems will be installed and be operated alternately to supply water to the trial farm.

Pump -

Capacity:	440 l/min.
Bore diameter:	80 m/m
Total head:	38 m
Power consumption:	5.5 KW
Pump type	Turbine pump

Prssure tank -

Capacity	1.1 cu.m.
Starting pressure	2.3 kg/sq. cm.
Stop pressure	3.8 kg/sq. cm.

Distributing pipes

Diameter	13-65 m/m
Length	Approx. 400 m.

4-3-3. Garden Irrigation

In the dry season, the turf, trees and flowers in the trial farm garden must be adequately irrigated. The irrigation water will be supplied from the Intake No. 2 and be conveyed with pipes to the gardens. Irrigation will be made by portable sprinkler sets, assuming the water rate of 5 mm/day for the area of 12,400 sq.m.

Pressure water supply system

Pump -

Capacity	200 l/min.
Bore diameter	50 m/m
Total head	56 m
Power consumption	3.7 KW
Pump type	Turbine pump (5 stages)

Pressure tank -

Capacity	1.1 cu.m
Starting prssure	4.1 kg/sq.cm
Stop pressure	5.6 kg/sq.cm.

Distributing pipes

Diameter, main pipe	50 m/m
branch pipe	25 m/m
Length	Approx. 790 m
Requirement at terminal	40 l/min. (2 sprinkler sets)
Nos. of terminals	22 (5 places to be operated simultaneously)

4-3-4. Rain Water Drainage

The rain water shall flow in, or be led through the L-shape side ditches along the roads, to the catch boxes to be drained out through the underground drain pipes. The proposed drainage systems cover about 75% of the total lot area. In the plan, design rainfall intensity and a runoff coefficient are assumed to be 80 mm/hr and 1.0, respectively.

Drain pipes

Diameter	150-400 m/m
Length	Approx. 840 m

Catch box

Size	0.45 m x 0.45 m/0.6 m x 0.6 m
Quantity	58 boxes/24 boxes
Depth	0.5-0.6 m

L-shape ditches

Length	1,450 m

4-3-5. Sewage Disposal

To maintain the good environmental condition and quality of water around the trial farm, all waste water will be collected to purification plants to be disposed and discharged to the outside of the trial farm through the rain water drain pipe system. The following facilities for sewage disposal are proposed:

Septic tanks	Two tanks - the one available for 20 persons capacity and the other available for 30 persons capacity
Drain pipes	ϕ = 100 m/m

4-4. Architectural Specification

A close care was exercised in designing the facilities on the folloiwng basic concepts:

- To harmonize the facilities with the environment
- To design with consideration for facilitating construction works
- To be available in easy procurement of materials
- To possibly reduce construction cost

In view of the above point, all proposed buildings are to be constructed by the conventional method of Thailand with local materials fully utilized. The design of foundation works shall be made in detail in accordance with the geological survey to be succeeded at the site.

The structure and finishing of the buildings have a little difference in each facility but their outline is as follows:

Structure: Foundation pile

Wooden pile	:	L = Approx. 5 m
P.S. concrete pile	:	L = Approx. 5 m for rice warehouse, machine shed, garage and repairshop

	Foundation	:	Reinforced concrete
	Column	:	Reinforced concrete
	Tie beam	:	Wooden beam in principle, but steel truss for shed, garage, and repairshop
	Wall	:	Wooden framework concrete block
	Floor	:	Wooden elevated framing and concrete ground floor
Finishing:	Roof	:	Corrugated asbestos sheet
	Exterior wall	:	Boarding (oil painted), mortar finishing (emulsion painted)
	Pillar, foundation	:	Mortar brushing (emulsion painted)

The further details on building design are referred to the Drawings and the following specifications:

Management office

		(sq.m)
Area	Building area	512
	Floor area	512
	Floor area for Director's room	18
	Office room	68
	Meeting room	30
	Leader's room	18
	Experts' room	54
	Laboratory	36
	Preparation room	18
	Lecture room	54
	Locker & shower, W.C.	36
	Others	10
	Sub-total	342
	Terrace & corridor	170
	Total	512

Number of stories:	Two stories elevated single floor
Structure:	Wooden structure, partially reinforced concrete; Foundation pile: Wooden pile L = Approx.5m
Equipments:	Complete set of supply, sanitary drain equipments and electric equipment
Finish:	Refer to the Drawings

Rice warehouse. The general specifications of the cold storage rooms equipped for the purpose of storage test is as follows:

Structure	75 mm thick foamed styrole on concrete block wall of 150 mm thick	
Outside max. temperature	40°C	
Planned room temperature	5°C	15°C
Planned room humidity (variable)	70%	70%
Required cooling capacity	1,200 Kcal /hr.	900 Kcal/hr.
Cooling units	2 x air-cooled type cooling units of 1,300 Kcal/hr of capacity	
	Power consumption 1.5 KVA/each	
Humidifier	2.5 - 3.0 l/hr, 0.1 KVA 2 sets	

Repairshop. The repairshop is designed in the non-flammable structure as well as the machinery sheds and garage. The fittings of main entrance are to be manual operation steel shutter. A hoist crane with one ton capacity and a one meter deep pit are equipped for the convenience of repair.

CHAPTER 5. PROJECT IMPLEMENTATION

5-1. Construction Program

5-1-1. Working Conditions

The operation schedule of the construction machineries was established in various conditions and actual results in Thailand as mentioned below.

- Conversion coefficient of the soil -

Properties	Natural condition	Excavated loose condition	Compacted condition
clay soil	1.00	1.35	0.90

- Operation hours was determined at 10 hours per day in referring to the actual results in Thailand.
- Five of annual working months and 25 of monthly working days.

5-1-2. Land Consolidation Works

The land consolidation project is composed of these construction works of land clearing, embankment of farm roads and ditches, excavation of ditches and drains and land levelling.

Land clearing works. Trees, bushes and useless ridges, and other obstacles will be eliminated for clearing the job-site of land consolidation. Some of the bigger trees, which have been indicated by the land owners, will be left standing in the field, or be transplanted. The bulldozers (140 HP), having working capacity of 1.0 hr/ha, will be employed for land clearing works.

Embankment of farm road and farm ditches. The embankment of farm roads and farm ditches will be made in better utilization of the earth cut-off by the levelling of the fields and excavated earth from the drainage ditches. The crawler type scrape-dozer (6.4 cu.m), which is suitable to transport-action for medium distance and working on the soft ground, and/or bulldozer (140 HP) will be employed for cutting off and hauling of the earth.

Since the community road is designed to have a lateral drainage canal along its one side, excavated soil from the canal can be used for embankment materials of the road, together with the earth cut-off by the land levelling in the adjacent field. A 60 PS class backhoe is employed for the works.

Excavation of farm and drainage ditches. Since the farm ditches will be provided just along the farm road, the construction works of the farm road and irrigation ditches shall be executed simultaneously. The farm ditches, which are not so deep, will be excavated by manpower. The drainage ditches will be excavated with backhoes (0.3 cu.m).

Land levelling. The bulldozer (140 HP) will be suitable for land levelling of short hauling distance, and the scrapedozer will be used for medium hauling distance. The levelling works involve the construction of necessary ridges, the required earth volume for which shall be pushed along the alignment of the relevant ridges. Motor-graders (125 HP), after levelling works completed will do finishing works.

5-2. Annual Implementation Schedule

The annual implementation schedule was formulated to be shown in TABLE 5-1, in taking into account the period of this Technical Cooperation service (5 years), budgetary factor, and effective operation of the machines to be introduced in the Project. The construction machineries, which shall be used in the works of the No. 1 Area, are planned to be converted to the implementation of the No. 2 Area.

The land consolidation works (362.1 ha) of the No. 1 Area are proposed to be implemented with the three years construction period; 46 ha in the first year of 1978 (Irrigation Units 13, 14, 20 and 21-1), 168.4 ha in the second year (Irrigation Units 1-4, 15-19, 21-2 and 22) and 147.7 ha in the third year (Irrigation Units 5-12).

Part of the construction machineries will be transferred to the No. 2 Area (504 ha) in the third year to start the land consolidation works with an area of 212.9 ha (Water Management Group, No. 1). And the land consolidation works for the remaining area of 291.1 ha (Water Management Group No. 2 and No. 3) will be completed in the fourth year.

The experimental and applied research farms in the trial farm will be constructed in the first year so as to produce the good effect at the earliest stage of the Project. The construction of facilities lots and architectural works will be executed in two years, 1978/79 and 1979/80.

The proposed implementation schedule is shown in TABLE 5-1.

TABLE 5-1. Implementation Schedule

Work Items	Quantity	1978	1979	1980	1981	1982
A. No. 1 Pilot Project Area						
1. Land consolidation works	362.1 ha.					
2. Trial farm	9.9 ha.					
Experimental & research farms	6.33 ha.					
Facilities lots	2.25 ha.					
Water & sewage works						
Garden works						
Electric						
Architectural works	2,061 sq.m.					
3. Model farms	3 farms					
4. Procurement of construction Machineries	12					
B. No. 2 Pilot Project Area						
1. Land consolidation works	504 ha.					

5-3. Machineries and Equipment

The machineries and equipment to be granted are as listed in the following table.

TABLE 5-2. Provisional List of Machineries and Equipment

Items	Quantity	Fiscal Year (Japan) 1977	1978	1979	1980	1981
1. Project Administration						
Vehicles	unit 2	-	2	-	-	-
Meteorological recorder	L.S. 1	-	-	1	-	-
Stationaries	L.S. 1	-	1	-	-	-
2. Agricultural Infrastructure Development						
2-1. Construction Machineries						
Bulldozer 140 PS	unit 6	-	2	2	2	-
Backhoe 60 PS	" 2	-	1	-	1	-
Scrapedozer 6.4 cu.m	" 2	-	-	1	1	-
Motor grader 125 PS	" 1	-	-	1	-	-
Water truck 6 ton	" 1	-	-	1	-	-
3. Agricultural Supporting Services						
3-1. Trial Farm						
(Indoor Training)						
Calculator	unit 5	-	-	3	2	-
8 mm movie camera and projector	" 1	-	-	-	1	-
Slide projector	" 1	-	-	-	1	-
Blue print instrument	" 1	-	-	-	1	-
Cylinder press	" 1	-	-	-	1	-
Tape recorder	" 1	-	-	-	1	-
Microphone	" 1	-	-	-	1	-
(Indoor Trial)						
Microscope	unit 2	-	-	1	1	-
Binocular microscope	" 2	-	-	1	1	-
Thermo-control equipment	" 3	-	-	1	2	-
Refrigerator	" 2	-	-	1	1	-
Balance	" 4	-	-	2	2	-
Moisture meter	" 2	-	-	1	1	-
Airconditioner (Seed storage)	" 2	-	-	2	-	-
Humidifier (Seed storage)	" 2	-	-	2	-	-

(Table 5-2 cont'd.)

Items	Quantity	Fiscal Year (Japan) 1977	1978	1979	1980	1981
(Field Trial and Training)						
Tractor 30 HP	unit 2	-	-	1	1	-
Tractor attachments	L.S 3	-	-	1	1	1
Power tiller	unit 2	-	-	2	-	-
Power attachments	L.S 3	-	-	1	1	1
Rice planter	unit 5	-	-	3	1	1
Combine harvester	" 5	-	-	1	2	2
Pest control equipment	" 5	-	-	2	2	1
Winnower	" 1	-	-	1	-	-
Thresher	" 1	-	-	1	-	-
Rice mill equipment	" 2	-	-	1	1	-
Pump for irrigation	" 5	-	-	2	2	1
Cargo truck	" 2	-	-	-	1	1
Cargo truck with crane	" 1	-	-	-	1	-
Workshop equipment	L.S 1	-	-	-	1	-
Fertilizer	t 20.4	-	-	5.1	7.7	7.6
Agri-chemicals	100 kg	-	-	4.7	6.8	6.9
(Public Utility)						
Pump	unit 3	-	2	1	-	-
3-1. Model farm						
Tractor 30 PS	unit 3	-	-	2	1	-
Power tiller	" 3	-	-	2	1	-
Fertilizer	t 2.8	-	-	-	1.4	1.4
Agri-chemicals	kg 200	-	-	-	100	100

CHAPTER 6. PROJECT COST

The Project cost includes those items of the land consolidation, the purchase of construction machineries, agricultural supporting services, and the Project Administration.

The depreciation cost of the construction machineries are not included in such earth works that are executed with the machineries to be granted, as the procurement costs are appropriated in the special cost item. The cost for machineries was composed of the costs of machineries and their spare parts on the CIF Bangkok basis (foreign currency portion) and customs duty and other local handling charges equivalent to 25 percent of the CIF prices (local currency portion). The cost of agricultural supporting services was composed of those costs for construction of the trial farm and its necessary materials, and agricultural input materials for the model farms.

The project administration costs include engineering costs (for topographical surveys, design, supervision and so on), personnel expenses for experts (Thais) and officials concerned and miscellaneous office expenses, in addition to those of equipment and materials to be granted.

The construction works are planned to be implemented under direct operation of RID, except for architectural works for the trial farm.

The conversion rate of local currency and foreign currency was fixed at ฿20.0=US$1.00=¥270.00. The estimated
in TABLE 6-1.

TABLE 6-1. Project Cost

(Unit: '000 ฿)

Cost Items	Total Cost	Fiscal Year (Japan) 1978	1979	1980	1981
A. No. 1 Pilot Project					
1) Land Consolidation	3,619	460	1,683	1,476	-
2) Construction machinery	(15,270)	(3,230)	(6,511)	(5,533)	-
	19,091	4,037	8,138	6,916	-
3) Agricultural supporting service					
Trial farm					
Civil works	2,477	1,939	538	-	-
Architecture	4,848	-	4,848	-	-
Equipment & Materials	(5,108)	(15)	(1,361)	(2,632)	(1,100)
	5,673	16	1,526	2,905	1,226
Model farms	(684)	-	-	(437)	(247)
	752	-	-	480	272
Sub-total	(5,792)	(15)	(1,361)	(3,069)	(1,347)
	13,750	1,955	6,912	3,385	1,498
4) Project administration					
Materials & equipment	(533)	(400)	(133)	-	-
	641	481	160	-	-
Managerial expense	11,093	1,131	3,383	3,637	2,942
Sub-total	(533)	(400)	(133)	-	-
	11,734	1,612	3,543	3,637	2,942
Total	(21,599)	(3,645)	(8,005)	(8,602)	(1,347)
	48,194	8,064	20,276	15,414	4,440
B. No. 2 Pilot Project					
1) Land consolidation	2,452	-	-	1,036	1,416
2) Project administration	570	-	-	230	340
Total	3,022	-	-	1,266	1,756
C. GRAND TOTAL	(21,599)	(3,645)	(8,005)	(8,602)	(1,347)
	51,216	8,064	20,276	24,704	6,196

NOTE: Figures in parenthesis show the foreign currency are included in total.

CHAPTER 7. IMPACT OF THE PROJECT

7-1. Farm Budget Analysis

7-1-1. Evaluation Method

The comparative study of the investment and the produced benefits, both of which are converted into monetary values, will be commonly used for the evaluation of the projects. This evaluation method, however, will not be applicable to this Project, which is the pilot project aiming at trial farming, demonstration and training as the base for the agriculture development.

Such being the case, the farm budget analysis of the sample farm households shall be an assessment of this Pilot Project that will give an impact to the related farmers' income and farm economy.

7-1-2. Selection of Representative Farm Households

According to the survey for the economic condition of the farm households in the Mae Klong River basin, carried out by the Royal Irrigation Department (RID) on the selected 850 farm households (corresponding to about 1% of the total number of 88,727 farm households in the basin), one farm household possesses lands of 27.85 rai (4.46 ha) on an average. On the other hand, the latest survey shows that the average farmland per household is 28.8 rai in the No. 1 Project Area and 29.3 rai in the No. 2 Project Area. And, in this study the average cropped acreage of the representative farm household is determined to be 28 rai (4.48 ha).

The farming types of the representative farm households are established as shown in TABLE 7-2, taking account of the present and proposed land use and the aforementioned survey results by RID. In the Project Areas, rice is the principal crop and almost exclusively cultivated, followed by upland field crops. The present farmland use of the 21,800 rai in the Mae Klong basin is tabulated in TABLE 7-1, which shows that rice is the main crop in the basin throughout the year.

TABLE 7-1. Land Use of the Sample Farm Households

(Unit: rai)

Crop	Wet Season		Dry Season		Sugar Cane	Total	
	Acreage	%	Acreage	%	Acreage	Acreage	%
Rice	14,627	92.7	1,146	68.3	-	15,773	72.4
Sugar cane	-	-	-	-	4,351	45,351	19.9
Vegetables	919	5.8	262	15.6	-	1,181	5.4
Other upland crops	236	1.5	270	16.1	-	506	2.3
Total	15,782	100	1,678	100	4,351	21,811	100

NOTE: Data Source, RID (1976)
No. of sample: 850 farm households

The farm budget analysis of the representative farm households was conducted in typical three kinds of farmers on the basis of farming types as listed in TABLE 7-2.

TABLE 7-2. Farming Type and Size of the Representative Farm Households

(Unit: rai)

Items	No. 1 Area		No. 2 Area	
	Present	Proposed	Present	Proposed
Farm size	28	28	28	28
1. Paddy (exclusive)				
Paddy, wet season, transplanted, LV	28	-	24	8.4
Paddy, wet season direct sowing, LV	-	-	4	-
Padddy, wet season, transplanted, HYV	-	28	-	19.6
Paddy, dry season, transplanted, HYL	-	28	-	28
2. Paddy and sugar cane				
Paddy, wet season, transplanted, LV	-	-	21	7.5
Paddy, wet season, direct sowing, LV	-	-	4	-
Paddy, wet season, transplanted, HYV	-	-	-	17.5
Paddy, dry season, transplanted, HYV	-	-	-	25
Sugar cane	-	-	3	3
3. Paddy and vegetable				
Paddy, wet season, transplanted, LV	26	-	22	7.8
Paddy, wet season, direct sowing, LV	-	-	4	-
Paddy, wet season, transplanted, HYV	-	26	-	18.2
Paddy, dry season, transplanted, HYV	-	26	-	26
Vegetable	2	2	2	2

The present gross farm income and farm production costs per rai are determined based on the results of the farm household economy survey by RID, and farm income by crop per rai is estimated as shown in the following table. In the calculation, gross farm income and production costs of vegetables are averaged those of six main crops, each three crops in both seasons of wet and dry.

TABLE 7-3. Farm Income per Rai by Crop (1976)

	Paddy			
	D.S.	T.P.	Sugarcane	Vegetables
1. Gross income				
Yield (kg/rai)	184	277	8,900	509
Price (฿/kg.)	2.2	2.2	0.297	3.98
Gross income (฿)	405	609	2,643	2,026
2. Production cost (฿)				
Hired tractor	55	55	233	121
Hired laborer	32	82	242	294
Transportation	6	6	411	10
Fertilizer	39	93	89	72
Agri-chemicals	52	39	41	78
Others	18	28	119	58
Sub-total	202	303	1,135	633
Interest	36	54	202	113
Total	238	357	1,337	746
3. Farm income (฿)	167	252	1,306	1,280

NOTES: D.S. = Direct Sowing
T.P. = Transplanting

7-1-3. Farm Income

The farm income with project of the representative farm households is estimated on the basis of 1976 price level according to the expected yield and proposed land use. In the calculation, since no reliable data of production costs in the Area is available, the estimation is made on

condition that the hired labor cost and transportation cost shall be increased by 75% in the No. 1 Area and 50% in the No. 2 Area due to the implementation of intensive land use. The annual interest is estimated by multiplying the total of production cost by the same rate of 17.83% as the RID survey.

Farm income with project per ha is estimated as listed in TABLE 7-4. In the estimation, farm income of vegetable shows the average of 6 main crops, and the yield of wet season paddy in the No. 2 Area takes an average of HYV (560 kg/rai, 70%) and LV (448 kg/rai, 30%).

The present farm income and expected farm income of the representative farm households are estimated for each farming type given in TABLE 7-2 by applying the farm income shown in TABLE 7-3 and TABLE 7-4. The average living cost per farm household in the Area seems to be around ฿15,000 per annum.

TABLE 7-5 shows the farm balance sheet of the representative farm households, from which it is evident that the farmers' income would increase to a great extent mainly resulted from intensive land use, and that the farm households could not only maintain the standard living from only farm income, but also they could bear a farm surplus.

7-2. Far-reaching Effect of the Project

The direct effect the Project would produce was already evaluated in monetary conversion in the preceding paragraph 7-1.

The Project has particular features as pilot works with very small area for the irrigated agriculture development project involving fundamental and a great deal of works such as providing necessary agri-infrastructures for paddy double cropping, the trial farm, many farming inputs, model farms, intensive guidance of farming techniques together

TABLE 7-4. Farm Income per Rai with Project by Crop

Items	Paddy: Wet	Paddy: Dry	Sugarcane	Vegetables
A. No. 1 Pilot Project Area				
1. Gross income				
Production (kg)	672	752	12,800	1,530
Price (฿/kg)	2.2	2.2	0.297	3.98
Gross income (฿)	1,478	1,654	3,802	6,089
2. Production cost				
Hired cost	215	215	1,330	1,913
Fertilizer & agri-chemicals	262	287	196	630
Others	192	148	852	753
Cost (฿)	619	650	1,378	3,296
3. Farm income (฿)	859	1,004	1,824	2,793
B. No. 2 Pilot Project Area				
1. Gross income				
Production (kg)	482	640	12,800	1,530
Price (฿/kg)	2.2	2.2	0.297	3.98
Gross income (฿)	1,060	1,408	3,802	6,089
2. Production cost				
Hired cost	251	251	1,551	2,231
Fertilizer & agri-chemicals	262	287	196	630
Others	152	160	518	847
Cost (฿)	665	698	2,265	3,708
3. Farm income	395	710	1,537	2,381

with efficient agri-supporting services like upbringing of the farmers' organization.

Under those conditions required for successful project execution, the services should not be only rendered to the improvement of the farm management of the farmers in the Project Area, but also expected to produce far-reaching effect as mentioned below.

1) The satisfactory land consolidation will be realized to improve the labor conditions of the farmers facilitating introduction of farm mechanization, and will encourage the farmers for upgrading their living standard through effective water control, demonstration of considerable yield increase.

2) The actual favourable results of improvement of farm management to be gained in the model farms would be recognized by the Government officials concerned, which would promote the extension of the irrigated agriculture.

3) The farmers could live on the agriculture in depending upon the high yieldings and devote themselves to the farming works to result in the upgrade of the farming techniques.

4) The trial farm to be provided in the Project Area shall function as nucleus of the technical guidance for the farmers not only in the Project Area, but in its vicinity.

5) The cooperative services rendered by the experts of both countries, Thailand and Japan, will give direct and practical guidance to the farmers through their activities in trial farm, model farms, land consolidation works, etc., and these close relation between each other will be a great help of mutual understanding.