THE FEASIBILITY STUDY
ON

THE LOWER NORTHEAST MEDIUM SCALE IRRIGATION PACKAGE PROJECT

IN
THE KINGDOM OF THAILAND

MAIN REPORT

July 1984

JAPAN INTERNATIONAL COOPERATION AGENCY

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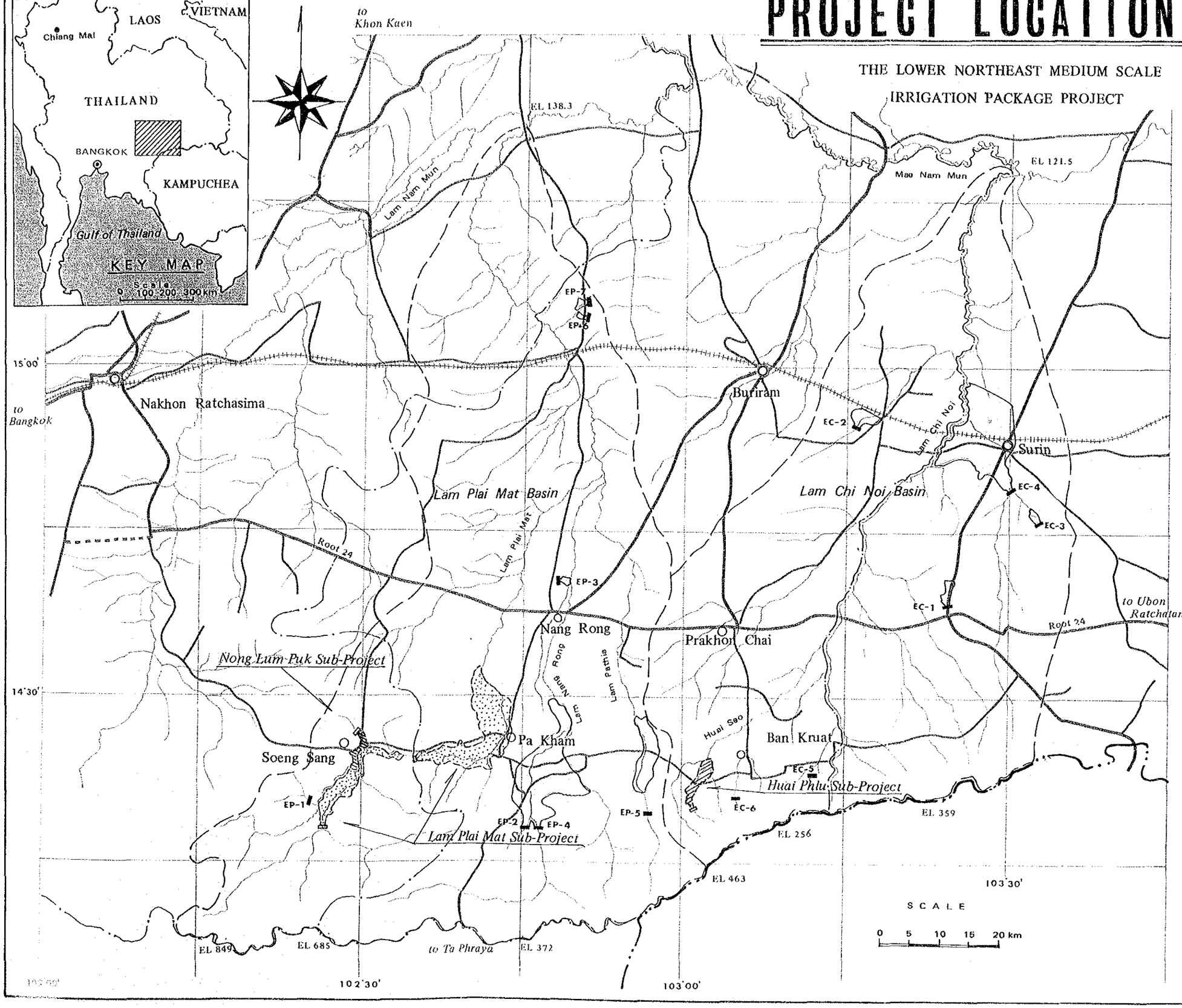
PROJECT LOCATION MAP

THE LOWER NORTHEAST MEDIUM SCALE
IRRIGATION PACKAGE PROJECT



LIST OF PROPOSED SUB-PROJECTS

LAM PLAI MAT BASIN

1. Lam Plai Mat Sub-Project
2. Nong Lum Puk Sub-Project

LAM CHI NOI BASIN

3. Huai Phlu Sub-Project

LIST OF EXISTING IRRIGATION SYSTEMS

LAM PLAI MAT BASIN

EP-1	Huai Hin Weir
EP-2	Khlong Manao Tank
EP-3	Nong Thalok Tank
EP-4	Lam Nang Rong
EP-5	Lam Pathia
EP-6	Huai Noi Tank
EP-7	Huai Yai Tank

LAM CHI NOI BASIN

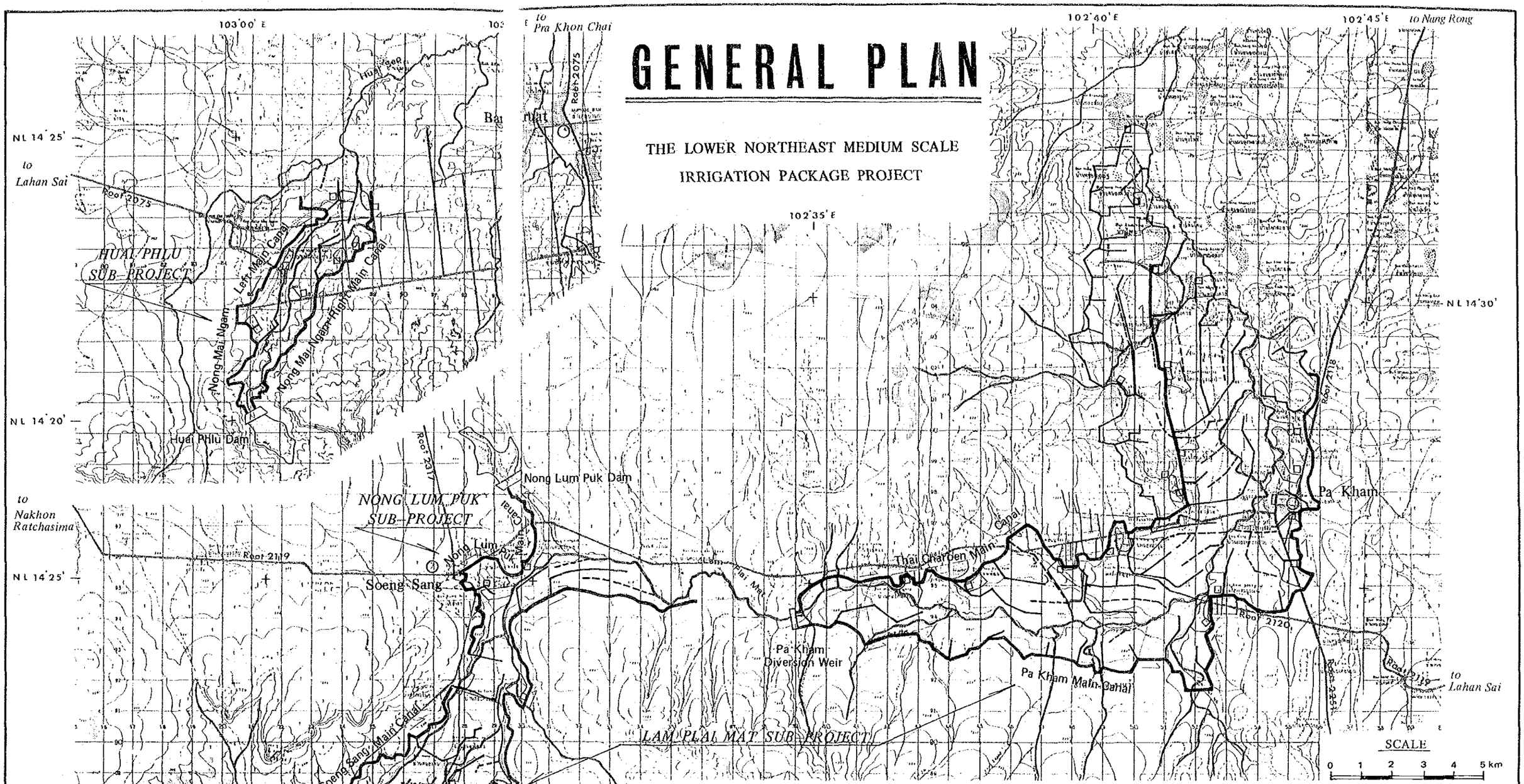
EC-1	Ban Kranang
EC-2	Huai Sawai Tank
EC-3	Am Pun Tank
EC-4	Huai Saneng Tank
EC-5	Huai Ta Kao
EC-6	Huai Mekha

LEGEND

- Changwat Boundary
- National Highway
- National Highway (Plan)
- Changwat Highway
- Basin Boundary
- Existing Irrigation System
- Proposed Sub-Project

GENERAL PLAN

THE LOWER NORTHEAST MEDIUM SCALE IRRIGATION PACKAGE PROJECT



PROJECT SUMMARY

Item		Lam Plai Mat Sub-Project	Nong Lum Puk Sub-Project	Huai Phlu Sub-Project
A.	Dam			
	– Reservoir Area (sq.km)	10.4	1.2	1.4
	– Dam Type	Zone	Homogeneous	Homogeneous
	– Height (m)	44.6	12.0	20.0
	– Length (m)	1,160	1,156	844
B.	Length of Canal (km)			
	– Main Canal	94.9	10.2	19.8
	– Lateral Canal	120.2	2.5	8.8
	– Drainage Canal	44.5	–	0.7
C.	Service Area (ha)	9,100	300	700
D.	No. of Village (1983)	60	4	9
E.	No. of Farm Households (1983)	7,630	690	810

LEGEND

- Dam
- Diversion Weir
- Main Irrigation Canal
- Lateral Irrigation Canal
- Drainage Canal
- Irrigation Area (Ordinary Service Unit)
- Irrigation Area (Muban Cooperative Service Unit)
- Muban Pond

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ABBREVIATIONS AND GLOSSARY

Abbreviation and Glossary

DOAE	Department of Agricultural Extension
EGAT	Electricity Generating Authority of Thailand
MOAC	Ministry of Agriculture and Cooperatives
RID	Royal Irrigation Department, MOAC
JICA	Japan International Cooperation Agency
changwat	Province
muang	Capital of Province
amphoe	District
tambon	Sub-district
muban	Village
Mae Nam	Large River
Nam	A medium-size river
Lam	A small river
Kwae	A tributary of a river
Huai	A rivulet
HYV	High Yielding Varieties
LV	Local Varieties
IRR	Internal Rate of Return
Rai	Unit of land measurement
Baht	Unit of Thai Currency
mm	Millimeter
cm	Centimeter
m	Meter
cu.m	Cubic meter
MCM	Million Cubic Meter
cu.m/s	Cubic meter per second
km	Kilometer
sq.km	Square kilometer
g	Gram
kg	Kilogram
ton	Metric ton
ha	Hectare
El	Elevation above mean sea level
MSL	Mean Sea Level
°C	Degree Centigrade
mmho/cm	Millimho per centimeter
HP	Horsepower

Units of Measurement

Rai	=	0.16 hectares = 1,600 sq.m
Hectare	=	6.25 rai = 10,000 sq.m

CHAPTER I INTRODUCTION

CHAPTER I. INTRODUCTION

1.1. Background of the Project

The Project Area extends over the Lam Plai Mat and the Lam Chi Noi basins in the Lower Northeast region and lies in the poorest region in Thailand due to shortage of water for the wet season paddy and domestic needs as well as poor communication system.

The Project service areas are presently plagued with fluctuations in wet season paddy yields, as a result of insufficient supplementary irrigation during drought periods and without an opportunity to cultivate any crop during the dry season. Furthermore, the water is insufficient in meeting the minimum requirement of domestic needs for people and animal, subsistence agriculture and related activities.

Under these circumstances, the Thai government has made great efforts in the water resources development in the form of SSIP, and its number reaches 129 in these two basins. It would be, however, rather impossible to alleviate the poverty of the majority of the farmers through the SSIP which is characterized by limited scale and budget. Implementation of the medium scale irrigation projects would be an urgent prerequisite to solving the poverty problem.

The government of Thailand requested the government of Japan to extend technical aid for the formulation of the development plan in this Project Area.

In response to the request of the government of Thailand, the government of Japan decided to undertake the Feasibility Study on the Lower Northeast Medium Scale Irrigation Package Project (hereinafter referred to as "the Study") within the general framework of technical cooperation between Thailand and Japan which was set forth in the Agreement of Technical Cooperation signed on

5 November 1981 between the two governments. The Japan International Cooperation Agency (JICA), the official agency responsible for the implementation of technical cooperation programs of the government of Japan, commenced the Study in close cooperation with Royal Irrigation Department, Ministry of Agriculture and Cooperatives, and other authorities concerned.

The Scope of Work, which has been prepared on the basis of the results of preliminary survey for the Study, describes the items to be studied, the working schedule to be followed, the services and facilities to be provided by the Thai government, and other necessary arrangements for smooth execution of the Study.

1.2. Objectives of the Study

The Study covering the two basins of the Lam Plai Mat and Lam Chi Noi in the Lower Northeast region, principal tributaries of the Mae Nam Mun, was scheduled to be carried out in two phases, viz. Study A and B:

Study A --- To conduct the overall study of the two basins; and

Study B --- To conduct the feasibility study on the first priority sub-projects (hereinafter referred to as "the Package I") which will be selected through Study A.

More particularly, the objectives of the Study are:

(a) To prepare the water resources development plan for the two basins in Study A;

(b) To identify the first priority sub-projects (the Package I) in Study A;

(c) To prepare the Feasibility Study of the Package I in Study B;

(d) To prepare basic and processed data obtained through the Study with a view to formulating the criteria/guidelines for project preparation which will help to rationalize the Feasibility Study of similar projects, especially the Small Medium Projects in the Northeast, in Study B; and

(e) To undertake on-the-job training of the Thai government officials in the course of Study A and B.

1.3. Background of the Study

The field work in Study A was carried out by the Study Team from 6 February to 31 March 1983. The Study Team prepared and submitted to the Royal Irrigation Department the Interim Report of Study A on 28 March 1983, that mainly covers the findings of the overall basin study and the first and second screening of the potential sub-project.

Following the above field work, the home office work was undertaken to finalize Study A. The Progress Report was compiled and submitted to the Royal Irrigation Department on 13 June 1983 mainly covering the Study Team's findings obtained during the course of home office work in general. This Report was intended for the project selection study to identify the first priority sub-projects in particular and for discussion with the Royal Irrigation Department and other government agencies concerned.

The Preliminary Report which was submitted in August 1983 compiled all the findings and recommendations obtained from Study A and the project selection study to identify the Package I Project based on the Minutes of the Meeting signed on 20 June 1983. In accordance with the result of Study A, the following three sub-projects were selected for the Feasibility Study in Study B.

- Lam Plai Mat Sub-Project
- Nong Lum Puk Sub-Project
- Huai Phlu Sub-Project

The field work for the Feasibility Study of the above three sub-projects was carried out from 4 September to 17 December 1983.

This draft Final Report has been compiled according to the results of survey in the field and studies conducted in Japan, as well as on the basis of numerous discussions held among the Thai officials, the Supervisory Committee and the Study Team. Members of the Supervisory Committee, the Thai counterpart personnel assigned to the Project and the Study Team are listed below:

(1) Supervisory Committee:

1)	Mr. Ryoichi SASAKI (Chief)	General Manager, Abukuma-Yamizo Field Office, Agricultural Land Development Public Corporation
2)	Mr. Akio SATO (Irrigation)	Deputy Director, Irrigation and Drainage Division, Construction Department, Agricultural Structural Improvement Bureau, MAFF
3)	Mr. Yoshinori SATO (Dam and Structures)	Section Chief, Yoichi Agriculture Department Office, Otaru Development and Construction Department, Hokkaido Development Bureau Prime Minister's Office
4)	Mr. Norio SHIMADA (Agronomy)	Deputy Director, Agricultural Water Utilization Office in Omono River Basin, MAFF
5)	Mr. Satoshi SUGAWARA (Agricultural Economy)	Section Chief, Project Planning Division, Planning Department, Agricultural Structural Improvement Bureau, MAFF
6)	Mr. Tooru SHIBUICHI (Economic Evaluation)	Deputy Manager, 2nd Technical Appraisal Division, Economic Research and Technical Appraisal Department, Overseas Economic Cooperation Fund

(2) Study Team:

1)	Mr. Shoichiro HIGUCHI	Team Leader, Sanyu Consultants Inc. (SCI)
2)	Mr. Yasushi MIYAZAKI	Irrigation & Drainage, SCI
3)	Mr. Hironori TAKAHASHI	Reservoir-Dam, SCI
4)	Mr. Takao KUME	Diversion Weir, SCI
5)	Mr. Toshinori KAWAMURA	Canal, Naigai Engineering Co., Ltd.
6)	Mr. Toyotaka NIWA	Meteorology & Hydrology, Naigai Engineering Co., Ltd.
7)	Mr. Hisao ANDO	Geology, SCI
8)	Mr. Munehisa MURAYAMA	Embankment Materials, SCI
9)	Mr. Kazuo NAKABAYASHI	Soil & Land Use, SCI
10)	Mr. Yasunori HASEGAWA	Agriculture, SCI
11)	Mr. Mitsutomo ANAI	Agro-Economy, SCI
12)	Mr. Tsugio KOISHI	Construction Planning and Cost Estimation, Naigai Engineering Co., Ltd.

(3) Counterpart Personnel:

1)	Mr. Chanchai Klionhorm	Chief of Medium Scale Irrigation Project, Project Planning Div., RID
2)	Mr. Supajana Rijirakul	Head for Regions III & IV, Medium Scale Irrigation Project, Project Planning Division, RID
3)	Mr. Nikom Israngkura	Assistant Director RID Region VI
4)	Mr. Viraj Chutiman	Chief of Survey Branch RID Region VI
5)	Miss Supha Sing-Intara	Chief of Economic Branch, Project Planning Division, RID
6)	Mr. Prasat Milinthangkul	Chief of Research and Applied Hydrology Section, Hydrology Division, RID
7)	Mr. Sanong Patasuk	Chief of Data Processing Section, Hydrology Division, RID

8)	Mr. Thada Sukapunaphand	Acting Chief, Hydrological Investigation, Lower North-east Region Branch, Hydrology Division, RID
9)	Mr. Supot Promnnaret	Chief of Computer Center, Planning Division, RID
10)	Mr. Yongyut Vosnusit	Section Chief of Agri-cultural Irrigation Operation and Maintenance Division, RID
11)	Mr. Sawat Yasaravana	Senior Irrigation Engineer, Design Division, RID
12)	Mr. Prayong Pingate	Laboratory, RID
13)	Mr. Yenjhai Kitpetch	Laboratory, RID
14)	Mr. Sangard Onnume	Economist, Economic Branch, Project Planning Div., RID
15)	Mrs. Surimuang Thrawornsing	-ditto-
16)	Mr. Osot Chanvej	Agronomist, Irrigated Agriculture Section, O & M Division, RID
17)	Mr. Apichai Watanayomanaporn	-ditto-

CHAPTER II BACKGROUND

CHAPTER II. BACKGROUND
-Significance of the Water Resources Development and Rural Poverty Alleviation in the Northeast Region-

2.1. Northeast Region: General

(1) Northeast Thailand, often called the Korat Plateau or the "Far Province", is one of the most important regions of the Kingdom particularly from the viewpoint of development policy. The Northeastern region has usually been regarded as the problem area of Thailand with a backward economy, low per capita income, limited transportation facilities and other constraints such as irregular distribution of rain water, poor soils and severe weather which are all deterrents to the economic and social development.

This problem has been aggravated by inadequate assistance from the Thai authorities. This has led to the development of an economy primarily meant for security and survival, viz. the local farmers grow rice under unfavorable conditions because if they had grown other crops they did not have a large market to exchange for food.

(2) When national and social disturbances began in Indochina after World War II, the isolation of the "Far Province" was an excellent precondition for infiltration. Thus, the political tensions have been added to the historical and geographical drawbacks of the Northeast. Insurgency can be traced back to the late 1950s, and terrorism and violence started in the mid 1960s.

There is recently an increasing problem along the common border with the Democratic Republic of Kampuchea where the rapid deforestation and destruction of forest in the watershed areas as are observed in the Lam Plai Mat and Lam Chi Noi basins have taken place with the uneven pattern of settlement of new communities that has

resulted in their isolation and hence underdevelopment; therefore, this weakness has paved the way for communist infiltration based in Kampuchea.

(3) On the alluvial plains and the lower parts of the low terrace, most of the original forests have been removed and the land used for the growing of transplanted paddy. In those areas, the paddy fields are flooded by impounded rain water during the wet season, and only one crop per year can be grown.

In some areas, irrigation water is used either from dam, tanks, or private systems, but the total area of irrigated land is very small. Conditions for improvement in the Northeast region is generally full of disadvantages and, therefore, the achievement of rapid progress towards well being of the population requires substantial investment with particular emphasis upon water control, soil fertility and land use classification which could lead to a scientifically-based agriculture.

(4) The General Land Capability Map (1972) permitting a rough estimate of the region's opportunities for developing its agriculture, indicates that (1) about one third of the land is too steep, too lateritic or otherwise unsuited for successful cropping, unless sufficient rehabilitation work, terracing, etc. are introduced to permit tree and upland crop cultivation; (2) another one third is regarded as rice land ranging from well to poorly suited rice soils; and (3) the remaining one third permits the growing of rice and, when drained, field crops, but only with moderate results.

(5) The total area of the Northeast region is 104.56×10^6 rai. Table 2-1-1 cited from "Water for the Northeast" (1978) Asian Institute of Technology (AIT) describes that the arable land is estimated at 62.6×10^6 rai, of which 22.6×10^6 rai are suitable for paddy and 39.9×10^6 rai for upland field crops; however, a large amount of land presently planted with paddy is unsuitable or marginally suited.

Table 2-1-1 also explains that the gravity irrigation schemes would be limited to approximately 8 to 9 percent of the farm families of the Northeast and the pumping irrigation may supply the wet season irrigation to additional 10 percent of the farm families living along reliable rivers. This means that 80 percent of the farmers will have to continue to rely upon rainfed agriculture, or particularly supplemented rainfed agriculture in the foreseeable future.

(6) Development of the Northeast region in the past decades has achieved expansion in every economic sector, especially agriculture, industry, transportation, commerce and services. Consequently, per capita income has increased by 5.9 times, rising from ฿1,082 in 1960 to ฿6,390 in 1982. However, the share of gross regional income which was 17.0 percent of the national income in 1960 had declined to 14.1 percent in 1981. This is primarily because agricultural output which is the main economic production of the region accounting for half of the total regional income in 1975 had been generated by the expansion of agricultural land which is currently exhausted. Infertile and marginal land has resulted in low-yields. It is, therefore, necessary to develop this low yielding agricultural area as well as those areas with deteriorating natural resources. (See Tables 2-1-2, 2-1-3, and 2-1-4).

Table 2-1-1 Arable Land, Water Storage and Irrigation Area in the Northeast

		rai	%
1.	Total area[1/]	104,560,000	100.0
2.	Arable land[1/]		
	Suitable for paddy	22,640,000	21.7
	Suitable for upland crops	39,920,000	38.2
	Total Arable Land	62,560,000	59.9
3.	Land use[2/]		
	Paddy	35,000,000	33.5
	Upland crops	8,125,000	7.8
	Total Cultivated Land	43,125,000	41.3

4. Effective storage	10^6
In existing large reservoirs	4,833
In existing tanks	778
Total Existing Storage	5,611
In planned reservoirs (excluding Pa Mong)	7,867
In planned tanks	915
Total Planned Storage	8,782
Total Potential Storage	14,393

5. Irrigable area	rai	%
From existing large reservoirs	1,193,300	1.1
From existing tanks	1,112,195	1.1
From pumping	1,900,000	1.8
Total Irrigable Area from Existing Resources	4,205,495	4.0
From planned large reservoirs (excluding Pa Mong)	2,218,650	2.1
From planned tanks	754,545	0.7
Total Irrigable Area from Planned Resources	2,973,195	2.8
Total Potential Irrigable Area	7,178,690	6.8

1/ --- The AIT estimates calculated by area measurements from 1:50,000 maps prepared by the Land Development Department, MOAC, 1978.

2/ --- IBRD, Appraisal of the Northeast Irrigation Project II (Washington, D.C.: The World Bank, 1978), Annex 2, Table 2. From Ministry of Agriculture and Co-operatives, Division of Agriculturai Economics, Agricultural Statistics Document No. 42, 1976.

Source: AIT "Water for the Northeast" (1978), Page 12.

Table 2-1-2 Structure of the 1982 Gross Domestic Product by Regions Concerned

-Current Price -

Industrial Origin	Changwat Nakhon Ratchasima			Changwat Buriram			Northeastern Region			Northern Region			Whole Kingdam		
	GDP		Per Capita GDP	GDP		Per Capita GDP	GDP		Per Capita GDP	GDP		Per Capita GDP	GDP		Per Capita GDP
	10^9฿	%	฿	10^9฿	%	฿	10^9฿	%	฿	10^9฿	%	฿	10^9฿	%	฿
Agriculture	4.996	31.1	2,449	2.589	40.7	2,140	38.561	35.2	2,248	43.002	37.6	4,299	177.152	20.6	3,654
Crops	3.908	24.8	1,916	2.021	31.8	1,670	29.389	26.8	1,713	34.280	30.0	3,427	129.825	15.1	2,677
Livestocks	1.011	6.3	496	0.440	6.9	364	6.949	6.3	405	6.402	5.6	640	22.227	2.6	458
Fisheries	0.047	0.3	23	0.077	1.2	64	1.219	1.1	71	0.660	0.6	66	13.544	1.6	279
Forestry	0.080	0.2	15	0.051	0.8	42	1.004	0.9	58	1.660	1.5	66	11.556	1.3	238
Mining & Quarrying	0.273	1.7	134	0.085	1.3	70	0.820	0.7	48	1.311	1.1	131	15.703	1.8	324
Manufacturing	1.570	9.8	770	0.362	5.7	299	8.807	8.0	513	7.724	6.8	772	177.146	20.6	3,653
Construction	1.397	8.7	685	0.270	4.2	223	6.447	5.9	376	5.375	4.7	537	44.821	5.2	924
Electricity & Water Supply	0.137	0.9	67	0.017	0.3	14	0.975	0.9	57	4.103	3.6	410	12.353	1.4	255
Transportation & Communication	0.734	4.6	360	0.411	6.5	340	7.719	7.0	450	7.430	6.5	743	68.863	8.0	1,416
Public Admini. & Defence	1.241	7.7	608	0.410	6.4	339	7.960	7.3	464	5.757	5.0	576	37.032	4.3	764
Others	5.727	35.6	2,807	2.221	34.9	1,836	38.315	35.0	2,233	39.664	34.7	3,965	325.481	37.9	6,712
Total (GDP)	16.075	100.0	7,897	6.365	100.0	5,235	109.604	100.0	6,390	114.366	100.0	11,434	858.371	100.0	17,702
	(1.87)		(0.45)	(0.74)		(0.30)	(12.8)		(0.36)	(13.3)		(0.64)	(100.0)		(1.00)
Population (10^6)	2.04	4.2		1.21	2.5		17.15		35.3	10.00	20.6		48.419	100.0	

Source: Gross Domestic Product (1978 - 82), NESDB

Table 2-1-3 Structure of the Gross Domestic Product in Agricultural Sector by Regions Concerned (1978, 1980 and 1982)

- 1972 Constant Price -

Gross Domestic Product at Constant Prices (1972)

	Agricultural Sector						Fisheries		Forestories		Total			Per Capita GDP
	Total		Crops		Livestocks									
	10^3฿	%	10^3฿	%	10^3฿	%	10^3฿	%	10^3฿	%	10^3฿	%	(10^6)	(฿)
Whole Kingdam														
1978	72.51	27.8	53.58	20.5	8.52	3.3	7.41	2.8	3.00	1.1	261.10	100	44.46	5.873
1980	72.78	24.9	54.18	18.5	9.01	3.1	6.28	2.1	3.32	1.1	292.85	100	46.46	6.304
1982	77.78	24.0	59.05	18.2	9.49	2.9	6.38	2.0	2.87	0.9	324.29	100	48.49	6.688
(1982/1978)	1.07	0.86	1.10	0.88	1.11	0.88	1.86	0.71	0.96	0.82	1.24	100	1.09	1.14
Northeastern Region														
1978	17.06	45.8	13.96	37.5	2.42	6.5	0.34	0.9	0.34	0.9	37.21	100	15.72	2.366
1980	19.36	44.1	15.61	35.6	3.08	7.0	0.40	0.9	0.27	0.6	43.90	100	16.44	2.671
1982	19.10	41.9	15.52	34.0	2.98	6.5	0.38	0.8	0.23	0.5	45.60	100	17.16	2.658
(1982/1978)	1.12	0.91	1.00	0.91	1.23	1.00	1.11	0.89	0.67	0.56	1.23	100	1.09	1.12
Changwat Nakhon Ratchasima														
1978	2.67	42.1	*2.24	35.3	0.40	6.3	0.014	0.2	0.012	0.2	6.34	100	1.88	3.371
1980	2.92	38.5	2.45	32.3	0.46	6.1	0.010	0.1	0.007	0.1	7.59	100	1.36	3.872
1982	2.87	36.7	2.40	30.6	0.44	5.6	0.015	0.2	0.006	0.1	7.82	100	2.04	3.839
(1982/1978)	1.07	0.87	1.07	0.87	1.10	0.89	1.07	1.00	0.50	0.50	1.23	100	1.09	1.13
Changwat Buriram														
1978	1.56	55.7	1.38	49.2	0.16	5.7	0.017	0.6	0.008	0.3	2.80	100	1.19	2.346
1980	1.56	54.4	1.30	45.31	0.25	8.7	0.013	0.5	0.001	0.03	2.87	100	1.15	2.482
1982	1.24	48.2	1.02	39.7	0.19	7.4	0.024	0.9	0.012	0.5	2.57	100	1.21	2.111
(1982/1978)	0.79	0.86	0.74	0.81	1.19	1.30	1.41	1.50	1.50	1.67	0.91	100	1.02	0.90

Source: Gross Domestic Product (1978 - 82), NESDB

Table 2-1-4 Interregional Comparison of the Gross Domestic Product (1960 - 82)

	Region					
	Northeastern	Northern	Southern	Central	Bangkok -Thonburi	Whole Kingdam
1. Gross Regional Product at Constant Prices (1972)						
1960	17.0	15.8	14.1	29.3	23.8	100.0
1970	16.0	15.2	12.8	27.3	28.5	100.0
1980	15.0	13.6	10.3	27.5	33.6	100.0
1982	14.1	13.5	10.1	29.6	32.7	100.0
2. Per Capita GDP at Current Prices (฿)						
1960	1,082	1,496	2,700	2,565	5,630	2,106
1970	1,822	2,699	3,858	4,662	10,234	3,849
1980	6,012	9,866	13,745	21,046	41,300	14,744
1982	6,390	11,434	14,376	27,244	50,779	17,702
3. Growth Rate of Per Capita GDP at Current Prices						
1960	1.00	1.00	1.00	1.00	1.00	1.00
1970	1.68	1.80	1.43	1.82	1.82	1.83
1980	5.56	6.59	5.09	8.21	7.34	7.00
1982	5.90	7.64	5.32	10.62	9.02	8.41
1980	1.00	1.00	1.00	1.00	1.00	1.00
1982	1.06	1.16	1.05	1.29	1.23	1.20
4. Interregional Comparison of Per Capita GDP at Current Prices						
1960	0.51	0.71	1.28	1.22	2.67	1.00
1970	0.47	0.70	1.00	1.21	2.66	1.00
1980	0.41	0.67	0.93	1.42	2.80	1.00
1982	0.36	0.65	0.81	1.53	2.87	1.00

Sources: 1. Fifth Plan (1982 - 86) Text, NESDB

2. Gross Domestic Product (1978 - 82), NESDB

2.2. Water Development as Top Priority in the Northeast Region

(1) Reference is made to "Water for the Northeast: A Strategy for the Development of Small-Scale Water Resources" presented by the Asian Institute of Technology in September 1978. This study was carried out at the request of the Water Resources Planning Subcommittee of the National Economic and Social Development Board, as a necessary step in its accelerated effort to formulate policies, programs and projects which could supply reliable water resources to farmers in the Northeast region.

This report contains many useful findings and applicable recommendations in challenging the water resources development, especially on the subject item "Medium Scale Irrigation Project". Some of the important implications compiled in this report are quoted below for further consideration.

(2) It has been revealed by many socio-economic surveys of mubans in the Northeast that their top priority is access to water for consumption and irrigation above roads, health, and education. This situation can be seen from Table 2-2-1 in responses from the Nam Yang Study area in changwat Roi Et belonging to RID Region V and also to the Lower Northeast region.

According to the survey conducted in July 1978 by extension agents of Adams International, Ltd., villagers' top priority for meeting their water requirements is the construction of new dams and reservoirs. Of second importance is the rehabilitation of existing systems, particularly cleaning and repairing of old canals and reservoirs in the vicinity of mubans. Thirdly important is irrigation pumps, followed by deep wells. Of lesser importance were requests for small ponds, fish breeding and agricultural extension services. This survey result appears in Table 2-2-2.

(3) During the course of field work for "Study A" of the Project, the village survey was conducted at four mubans and related amphoe offices in both the Lam Plai Mat and the Lam Chi Noi basins and some useful opinions were obtained on the present problems and difficulties among the local farmers:

- The most fundamental and top-ranking problem to be urgently solved is the lack of water for the wet season paddy, which was cited by 100 percent of the people interviewed. There were many opinions to strengthen the agricultural extension services and partly the farm credit services. Difficulties in getting drinking water have been expressed despite a great difference among localities.

- The second important item as explained by many personnel was to construct road networks among the villages to promote more communication. District Officer in amphoe Lam Plai Mat cited inundation once every three years besides a lack of irrigation water and road networks.

(4) The AIT "Water for the Northeast" has brought into prudent focus the following for water development;

- The strategy for achieving the water policy objectives in the Northeast should be premised upon the delivery of adequate water supplies to the largest number of farmers in the shortest possible time. Both the political and socio-economic premises pose a serious national challenge instituting a promising water policy for the Northeast at this time. Natural topography, land capability and rainfall constraints make it quite impossible, with the present knowledge and available resources, to provide irrigated agriculture throughout the Northeast.

- The water policy for the Northeast, thus, should follow a two-pronged approach, as summarized below:

  Emphasis upon distribution from existing sources:

  Rapid development of effective distribution systems from reservoirs and rivers, capable of actual delivery of water to the maximum number of farm families. Additional substantial investment in large and medium scale dam construction will be required on a rather long-term development basis.

  Meeting basic requirements:

  Rapid development of small water resources projects in every muban capable of meeting the basic subsistence requirements for domestic water needs, minimal supplementary irrigation, and minimal dry season irrigation of garden plots.

- In some locations, small scale reservoirs may be able to supply all the supplementary water needs for wet season rice. Suppose that farmers plant a subsistence crop of six rai per family, a muban reservoir supplying water for 600 rai of rice will require a capacity of 480,000 cu.m assuming average water requirement of 500 mm for a wet season paddy cultivation. This requirement is considerably larger and can only be justified in good locations where economic returns are reasonable and part of the initial construction cost and the operation and maintenance cost could be borne by the farmers.

Table 2-2-1. Ranking of Priority Project by People in Nam Yang Study Area in Changwat Roi Et

Project	Ranking	Amphoe Selaphum	Amphoe Phon Thong	Total	Total of Tops Three Choices
1. Road Construction	1st	20.8	16.7	18.8	
	2nd	27.8	22.4	25.6	60.4
	3rd	63.9	55.2	16.0	
2. School Construction	1st	5.2	2.6	4.2	
	2nd	9.0	10.9	9.8	26.7
	3rd	26.7	26.5	12.7	
3. Sanitary Station	1st	7.3	4.2	6.0	
	2nd	11.8	12.5	12.1	37.7
	3rd	38.5	37.0	19.8	
4. Village Development	1st	3.1	6.2	4.4	
	2nd	8.0	13.5	10.2	26.9
	3rd	22.9	32.8	12.3	
5. Police Station Construction	1st	-	-	-	
	2nd	1.0	2.6	1.7	4.6
	3rd	3.8	5.7	2.9	
6. Irrigation	1st	48.3	50.0	49.0	
	2nd	21.2	16.7	19.4	82.9
	3rd	81.9	84.4	14.6	
7. Water Procurement	1st	15.6	20.3	17.5	
	2nd	20.8	19.3	20.2	58.1
	3rd	59.7	55.7	20.4	
8. Other	1st	0.3	-	0.2	
	2nd	0.3	2.1	1.0	2.1
	3rd	2.1	2.1	0.8	
9. No idea, no response	1st	-	-	-	
	2nd	-	-	-	0.4
	3rd	0.3	0.5	0.4	

Source: AIT "Water for the Northeast" (1978), page 13, based upon United States Bureau of Reclamation and USOM, A Report on Socio-cultural Conditions in the Yang Study Area of Roi Et in Northeast Thailand (Bangkok: USOM, 13 Dcemeber 1968), p. 65.
There were a total of 288 responses from Amphoe Selaphum and 192 from Amphoe Phon Thong, amounting to a total of 480 responses in all.

TABLE 2-2-2 People's Priorities for Development of Small Water Resources Projects Based on Responses from 82 Tambons in the Northeast*/

Priority	Proposed Projects	Total Responses	% of Total Responses
1	Construction of small dams and reservoirs: construct dams (30), more budget for reservoirs (4), at least one reservoir in every village (2), people should help construct (1)	37	29
2	Improved operations and maintenance of existing systems: clean old canals and ponds (14), O & M budget for old canals (8), improve old reservoirs (5), more RID canals (4), improve natural canal and spillway (2)	33	25
3	Provision of pumps: to every village (17), during the dry season (7)	24	18
4	Provision of wells: in own village (12), in every village (3)	15	12
5	Building of small ponds	5	4
6	Providing fish in ponds	5	4
7	Miscellaneous suggestions: agricultural extension in every village (3), water supply (2), water for cousumption in dry season (2), irrigation for second crop (2), pipes for carrying water (1), no more cutting trees in forest (1)	11	8

*/ --- Based on a survey in July 1978 requested by the study team and conducted by extension agents of Adams International, Ltd., in 82 tambons of five changwat: Roi Et, Kalasin, Khon Kaen, Ubon Ratchathani, Srisaket, for a total of 130 recommendations.

Source: AIT "Water for the Northeast" (1978), page 14.

2.3. Poverty and Income Disparities in the Northeast Region

(1) The issues of poverty and income disparities in Thailand have increasingly become the focus of attention of the Thai government. This concern has been reflected in the Third and Fourth and, more directly, in the Fifth National Economic and Social Development Plan (1982-86) of Thailand, in order to develop improved policies and programs that could promote continuing poverty alleviation and equitable income growth.

Notwithstanding the rapid income growth and the significant reduction in poverty that have taken place in Thailand, the World Bank*/ estimates that the incidence of rural poverty is still 35 percent and the majority of the rural poor, some 55 percent, live in the Northeast. It is commonly interpreted that those farmers who have been unable to supplement traditional subsistence cultivation of rice with income from cash crops or wages have generally remained in the poverty group.

*/ ... "Thailand: Income Growth and Poverty Alleviation", 1980 World Bank.

The World Bank study identified a number of areas where the government programs in the past have had significant and positive effects on poverty alleviation; however, the study mentions that the evidence does not indicate that inadequate and poor distribution of certain basic services such as education and health services has been a major impediment to income growth throughout Thailand even in the Northeast region. And, the study continues to report that the analysis of survey data for the rural Northeast indicates additional factors which will make further poverty reduction more difficult in many areas where the incidence of poverty remains high, viz. factors contributing to poverty are very location-specific.

Although Thailand as a whole has achieved a remarkable overall economic growth during the past decades, the economic benefits have not been equitably shared, and the interregional and interpersonal income disparities have a tendency to increase to a great extent. (See Tables 2-1-2, 2-1-3 and 2-1-4.)

It is said that the proportion of people nationally classified as "POOR" has declined:

- In 1962/63, the people under the poverty line accounted for 57 percent of the national population. This was reduced to 39 percent in 1968/69 and further reduced to 31 percent by 1975/76. (See ANNEX J for Poverty Line.)

- The proportion of the rural poor by comparison was 61 percent, 43 percent and 35 percent, respectively.

Despite the falling proportion in the incidence of rural poverty, the fact shows that one third of the entire population is still in this category. More seriously, the continuing downward trend of the proportion of rural poor may be reversed in the near future due to a slower rate of expansion in the agricultural land. If agricultural productivity is not increased, the proportion of the rural poor would almost certainly cease to decline.

(2) A number of factors would be responsible for poverty and rural backwardness problems.

- One important factor is that past development objectives have concentrated almost solely on overall growth while expecting benefits from such growth to be trickled down to rural areas at a later stage. Consequently, direct resources allocation for rural development was relatively small.

- Past government investment programs for rural development tended to be welfare oriented without the people's participation. An obvious consequence is that when the government runs out of fund or has to withdraw, the rural people return to their former conditions and are unable to help themselves.

- When asked about the basic needs, the rural people tend to imitate the demands of a modernized area in the hope that they would be lifted from their present poverty position. Therefore, their demands were in the form of requests for roads, electricity and irrigation. This desire has a number of problems. The possession of roads and electricity, for example, would not necessarily and directly help solve the basic problems of the rural poor and not always help increase their productivity. The benefits of such development may not be shared equally by all the people. Most important is the people's ignorance of the true causes of their problems which has hindered their life improvement effort and has confined them to receiving only what is being offered by the government.

(3) It is reported that only a limited number of the rural people have benefited from past development, mainly in irrigated areas. A number of the studies indicate that there are not fewer than 10 million rural people who invariably suffer from economic hardship, notably in the Northeastern and Upper Northern regions.

Region	% of Rural Poverty Line (1975/76) -A-	Rural Population (1979) million -B-	No. of Rural Rural Poor (1979) million -A x B-	% of Total Rural Poor
Northeast	45	13.37	6.02	52
North	34	7.91	2.69	23
South	33	4.66	1.56	14
Central	15	8.40	1.26	11
Whole Kingdom	33.5	34.34	11.52	100

Source: Fifth Plan Text, pp. 276

(4) More particularly, the general characteristics of land and climate, as well as the poor suitability of soil with subsistence cropping patterns currently practised, play a large role in determining the incidence of poverty locally in the Northeast region. The specially poor areas are less susceptible to the introduction of irrigation, high-yielding varieties and crop diversification based upon known varieties of maize, cassava and other profitable crops than other parts of the country where rapid poverty reduction has occurred.

Under the situation as mentioned above, more programs oriented to specific local conditions will be required particularly in the Northeast making the most of the limited resources in water projects in an adequate manner as the top priority under recent international concepts of the "Basic Human Needs" (BHN by ILO) or "Basic Minimum Needs" (BMN by United Nations Center for Regional Development - UNCRD) which can surely yield the promised economic, social and hence political benefits through increase of agricultural production and improvement of the quality of the local farmers' livelihood.

(5) Tables 2-3-1, 2-3-2 and 2-3-3 which have been prepared based upon recently published government data in association with the Study Team's village survey in March 1983, clearly point out the severe poverty problems prevailing in the Northeast region.

As is seen in Table 2-3-1, the current income situation prevailing in the Lower Northeast would be decisively critical when compared with those of the Upper Northeast, since these sub-regions have distinct production characteristics. Moreover, the sample village survey in the basins of Lam Plai Mat and Lam Chi Noi conducted by the Study Team would support this fact and concurrently show that particular attention should be paid to proper measure for poverty alleviation prevailing in both the basins.

(6) The socio-economic conditions in both basins have been discussed in the form of the Overall Basin Study as compiled in the Preliminary Report for "Study A", August 1983, subdividing the Lam Plai Mat basin into 4 sub-basins and the Lam Chi Noi into 7 sub-basins.

The major finding indicates that both basins as a whole are subject to considerable fluctuations in wet season paddy yields as a result of inaccessible supplementary irrigation during drought period and there is no opportunity to cultivate any crop during the dry season.

This situation in the Lam Plai Mat basin would be more severe than that of the Lam Chi Noi Basin because of slight difference in rainfall, and the Upper sub-basins in both the basins would have more critical situations as compared with the Lower, since a surprising amount of the arable land reclamation through the conversion of the forests in Upper sub-basins has taken place due to the movement of farmers from the overpopulated Lower sub-basins and other regions.

The distribution of poverty by area in both the Study basins would show that it is more essentially related to the wet season paddy productivity of the land available to the farmers under traditional techniques. The net production value of wet season paddy produced per rai would be correlated significantly with the average household income across mubans, supporting the link between productivity and income level.

Under these circumstances, the water resources development in the form of the medium scale irrigation project in the Upper sub-basins has placed, among others, the highest priority on stabilization and promotion of the wet season paddy cultivation for the maximum number of farmers given rather scarce and limited water resources.

Table 2-3-1. Average Income of the Farm Households

(Unit: ฿ per year)

Region	Cash Income					Non-Cash Income (Family Consumption)	Total Income
	Agricultural Income				Non-farm Income		
	Crops	Livestocks	Others	Total			
A. Average Income per Farm Household							
1. Whole Kingdom 1/	19,078	3,220	909	23,207	11,330	4,943	39,480
2. Central Region 1/	36,480	4,192	1,952	42,623	14,315	4,464	61,402
3. Southern Region 1/	16,108	3,375	683	20,166	15,353	3,277	38,795
4. Northern Region 1/	18,430	3,073	983	22,486	9,799	5,242	37,527
5. Northeastern Region 1/	11,862	2,777	417	15,057	9,618	5,572	30,247
6. Sample Farms in the Lower Northeastern 2/	3,118	585	-	3,703	3,524	(not available)	(not available)
7. Sample Farm in the Study Basins 3/	3,964	597	31	4,952	4,401	5,010	14,003
B. Average Income per Capita							
1. Whole Kingdom 1/	3,600	608	171	4,379	2,138	933	7,450
2. Central Region 1/	7,153	822	383	8,358	2,807	875	12,040
3. Southern Region 1/	3,098	649	131	3,878	2,952	630	7,460
4. Northern Region 1/	3,840	640	205	4,685	2,041	1,092	7,818
5. Northeastern Region 1/	2,081	487	73	2,641	1,681	978	5,306
6. Sample Farms in the Lower Northeastern 2/	547	102	-	649	618	(not available)	(not available)
7. Sample Farms in the Study Basins 3/	619	93	5	718	655	783	2,156

Data Source: 1/... "Revenue and Expenditure of farmers Crop Year 1980/81" by Agricultural Research Division, Office of Agricultural Economics, MOAC, February 1983.

2/... "Socio-Economic Constraints in Rainfed Agriculture Production in the Lower Northeast, 1981" by National Economic and Social Development Board, Office of the Prime Minister. This survey was done covering 508 sample farm households, in the five Changwat (Nakhon Ratchasima, Buri Nam, Surin, Si Sa Kat, Ubon Ratchatani).

3/... "Village Survey in the Study Basins", March 1-4, 1983. This survey covering four Mubans and 96 farm households was made with the cooperation of the Economics Section of Planning Division, RID.

TABLE 2-3-2 Income and Expenditures by Region, 1975-76

Region	Household Size (persons)	Income: Average Annual Income Per Household (฿)	Income: Average Annual Income Per Capita (฿)	Income: Income Received in Kind (%)	Expenditures: Average Annual Expenditures Per Household (฿)	Expenditures: Average Annual Expenditures Per Capita (฿)	Food to Total Consumption (%)
1. Whole Kingdom							
Average	5.5	23,136	4,230	26.1	24,048	4,396	48.0
Villages	5.5	17,784	3,222	36.2	19,428	3,520	51.3
2. Greater Bangkok	5.7	41,304	7,310	12.5	39,876	7,058	42.4
3. Central Region, Villages	5.3	24,432	4,619	25.6	26,184	4,950	47.2
4. Southern Region, Villages	5.3	18,012	3,411	20.0	20,268	3,839	49.5
5. Northern Region, Villages	5.1	15,816	3,095	36.0	17,088	3,344	52.0
6. Northeastern Region							
Average	5.9	17,952	3,038	39.7	19,344	3,273	50.4
Villages	6.0	15,636	2,615	48.2	17,304	2,894	54.6

Source; "Socio-Economic Survey, 1975-76", National Statistical Office, Office of Prime Minister

TABLE 2-3-3 Land Use per Farm Household, 1980

(Unit Area -- '000 ha, Farm size -- ha per farm)

Region	Number of Farm Households	Paddy Land		Upland Crops		Fruit Tree, Tree Crop, Vegetable & Flowes		Others/*		Total	
		Area	Farm Size	Area	Farm Size	Area	Farm Size	Area	Farm Size	Area	Farm Size
1. Whole Kingdom	4,467,547	11,770	2.6	4,121	0.9	1,833	0.4	1,316	0.3	19,040	4.3
2. Northeast	1,786,465	5,742	3.2	1,584	0.9	86	0.1	603	0.3	8,015	4.5
3. Changwat in the Study Area											
a) Nakhon Ratchasima	190,618	564	3.0	437	2.3	16	0.1	89	0.5	1,106	5.8
b) Buri Ram	117,854	468	4.0	63	0.5	4	0	26	0.2	561	4.8
c) Surin	115,544	460	4.0	28	0.2	4	0	14	0.1	506	4.4
Total	424,016	1,492	3.5	528	1.2	24	0.1	129	0.3	2,172	5.1

NOTE: /* --- including housing area, grass and idle land.

Source; "Agricultural Statictics of Thailand, Crop Year 1980/81" by Office of Agricultural Economics, MOAC.

2.4. The Fifth National Economic and Social Development Plan (1982-1986)

- Poverty Allevation and Development of Backward Rural Areas
- Spatial Development of the Lower Northeast

2.4.1. General

The Fifth Plan (1982-86) has adopted a "New Line" of approach to the national development efforts to solve the current socio-economic problems which is different from the past Plans and mainly stresses "Economic Progress with National Harmony" with six major national development objectives. Of the six objectives, the fourth is to promote rural development in order to alleviate the poverty in backward areas which have so far been neglected.

It is clearly mentioned that the rural development programs in the Fifth Plan have been prepared based upon an entirely different concept from the past Plans, viz. (1) no success in rural development can be assured if there is no radical change in approach, and (2) the plan is no longer attaching major emphasis to overall output and national income.

The new rural development policy guidelines in the Fifth Plan have the following five salient features:

(1) To be area-specific, giving top priority to the high poverty concentration areas;

(2) To develop high poverty concentration areas so that the people will have enough to eat and clothe themselves. Basic public services will be made available in sufficient quantities;

(3) To initiate people's self-help programs;

(4) To solve the poverty problems in all localities with emphasis on low-cost and self-help techniques; and,

(5) To encourage maximum participation by the people in solving their problems.

2.4.2. Target Areas for Rural Development Programs in Fifth Plan

(1) The Prime Minister's Office Notification No.5 (Jan. 1981) "Designation of Target Areas for Rural Development Programs under the Fifth Plan (1982-86)", has specified the target areas for accelerated development of rural poors by naming amphoes.

Region	Changwat	Amphoe	King Amphoe
Northeast	16	129	18
North	16	65	7
South	5	22	5
Total	37	216	30
° In which: Nakhon Ratchasima		9	1
Buriram		3	0
° Within the Project Study Area:			
Nakhon Ratchasima		0	0
Buriram		2	0
(Prakhon Chai (Ban Kruat) : Huai Phlu Sub-Project			

Following this, tambons and mubans have been designated under the target amphoes. In the Huai Phlu Sub-Project study area, four tambons and 12 mubans are incorporated as is seen in other part of this Report.

(2) The principles in the selection of the target areas as illustrated in the Fifth Plan text are as follows:

- A clear concept of the target areas is that the principal selection criterion would be the actual physical areas, and not the income level, for two reasons. First, the concept using spatial distinction would assist in grappling with important causes of poverty concentration problems. Second, it would be necessary to solve poverty problems in the areas where the problems originate. If the people are not urgently assisted, they have to find ways and means of living and other social and political problems would certainly follow. The result would be the destruction of natural resources and the migration, both temporarily and permanently.

- The amphoe level would be the main point of reference. This is not because amphoes represent the units where the problems have their most common characteristics. The choice of amphoes is based upon the principle that they are well-endowed with data and information which are readily analyzed and tested.

- In distinguishing different level of poverty, the criterion of the concentration of problems would be used. When different amphoes in one region are compared, some amphoes would have a higher concentration of poverty problems than others. It can be stated that if the government can solve some problems in an amphoe with high poverty concentration, the general situation can be said to have been improved.

(3) The targets in the development programs for target areas are given below:

- Economic: ° To achieve additional growth of two percent per annum in the agricultural growth rate.

- Social: ° To provide amphoe-level primary health care services and supplementary textbooks for the entire population in the target areas.

° To provide nutritional services for 2.2 million pregnant women and children, potable water for inhabitants in 7,000 rural villages, and legal assistance to not less than 5,000 poor farmers.

Full details of the development programs are incorporated in "Rural Poverty Eradication Program" NESDB (1981), from which the items only are quoted below:

° Muban Activities:
1. Muban fisheries (Dept. of Fisheries, MOAC)
2. Muban water resources (Office of ARD, MOI)
3. Muban small animals (Dept. of Livestock Development, MOAC)
4. Cattle/Buffalo banks (Dept. of Livestock Development, MOAC)
5. Rural poor development project under the Japanese Loan Program, Stage 2 (Community Development Dept., MOI)

° Infrastructure Services:
1. Amphoe hospitals (Office of Undersecretary, MOPH)
2. Primary health care (Office of Undersecretary, MOPH)
3. Nutrition (Dept. of Health, MOPH)

4. Agricultural credit (BAAC)
5. Legal assistance (Office of Policy and Planning, MOI)
6. Supplementary textbooks (Dept. of Teachers' Training, MOE)
7. Clean water supply (Dept. of Health, MOPH)

° Production:

1. Production of nutritious food (Dept. of Agricultural Extension, MOAC)
2. High-land rice farming (Dept. of Agriculture, MOAC)
3. Soil improvement (Dept. of Land Development, MOAC)
4. Development of saline soil (Dept. of Land Development, MOAC)

2.4.3. Spatial Development of Lower Northeast in Fifth Plan

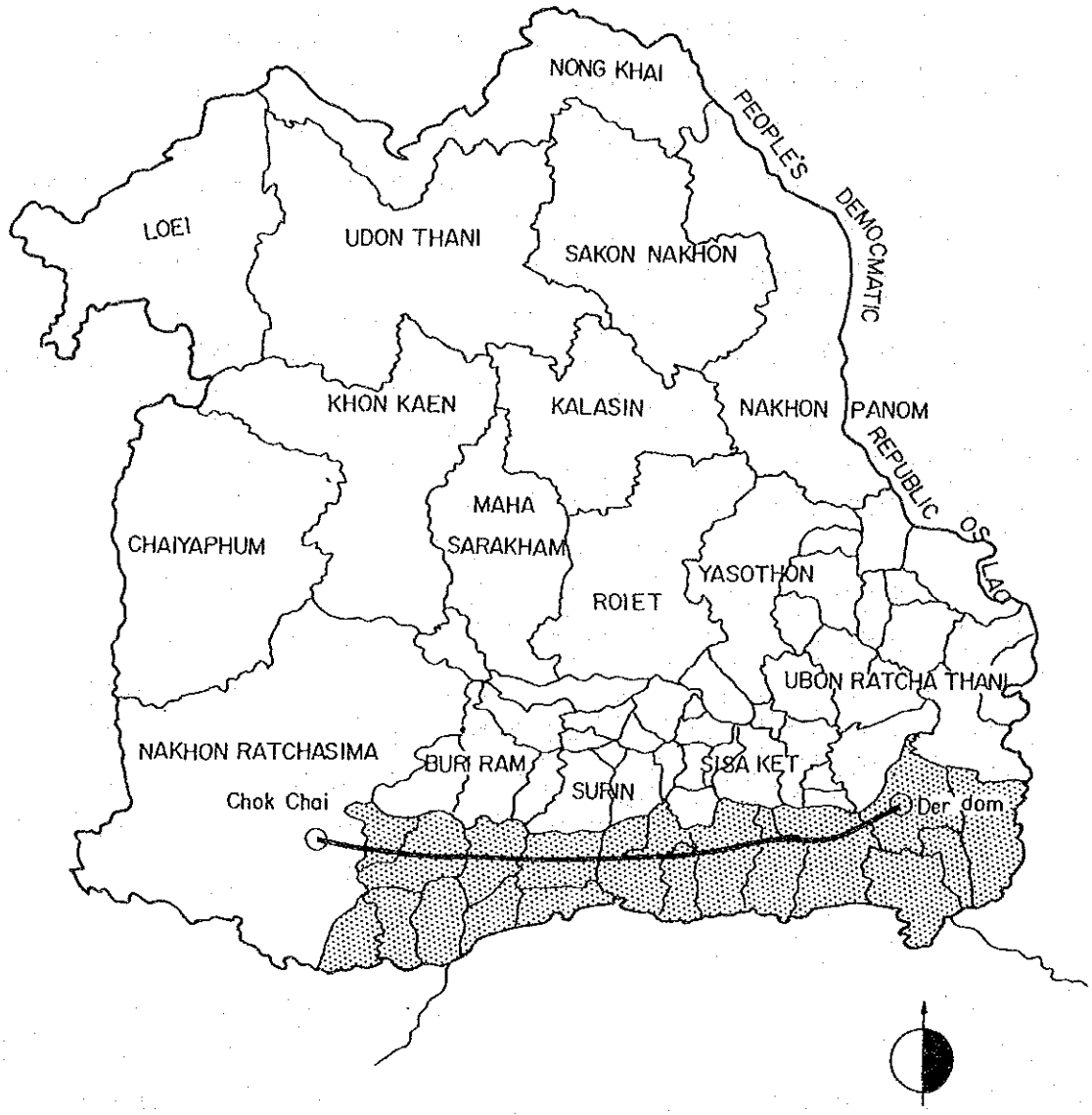
(1) The economic growth pattern during the past decades indicates that interregional and urban-rural disparities have increased. The majority of economic activities have been heavily concentrated in the central region, particularly in the Bangkok metropolitan areas, whereas the Northeast and the Upper North have had their share of production reduced. Concurrently, the growth pattern of urbanization has become increasingly imbalanced.

Under this circumstance, the Fifth Plan has laid down spatial development strategy to diffuse growth and decentralize economic activities to the regions. In this effort, five "Specific Areas" for accelerated development have been put forward including (1) Eastern Seaboard Region, (2) Western Region, (3) Upper North, (4) Lower Northeast and (5) Southern Border Provinces.

(2) Two selected areas in the Lower Northeast are Tung Kula Rong Hai and 19 border amphoes (see Figure 2-4-1). The development of the areas will improve the efficient utilization of land, water resources, and forests, thus increasing output per rai. The planned

FIGURE 2-4-1

NORTH EASTERN REGION



Nineteen Border Districts in the Lower Northeast

development will accord well with the agricultural restructuring policy, from land extension to improved efficiency of existing land utilization, and the development policy for national security purposes by the 2nd Army Region. The latter policy intends to develop a new and sound local community along the Thai-Kampuchean border to counter disturbances from outside the country.

(3) The 19 border amphoes extend over the administrative jurisdiction of the five southernmost changwat, i.e., Nakhon Ratchasima, Buriram, Surin, Sisaket and Ubon Ratchatani. The area extends parallel to the National Highway 24, Chok Chai - Dej Udom route, and along the common border with the Democratic Republic of Kampuchea.

It has a land area of 11.71 million rai, and a population of 1.51 million. Originally the area was a prosperous forest land, and a watershed area for a number of tributaries, such as Lam Plai Mat, Lam Chi Noi, Lam Chakaraj, Huai Samran, Lam Dom Yai, and Lam Dom Noi, which flow into the Mae Nam Mun. The water from these sources was sufficient for cultivation of one quarter of agricultural land in the whole region. The construction of the National Highway, No. 24, Chock Chai-Dej Udom route, which was completed in 1971, has opened up this vast area as additional farm land.

(4) It is noted that only amphoe Soeng Sang in changwat Nakhon Ratchasima is specially included which occupies the upper reach of the Lam Plai Mat and is situated on the western extension line of the designated 19 border amphoes specific area. Amphoe Soeng Sang is geographically separated from the main part of changwat Nakhon Ratchasima by the watershed boundary between the Lam Plai Mat and the Lam Sae. More particularly, it appears better that amphoe Soeng Sang would be transferred to changwat Buriram because of promotion of the sense of social solidarity of the rural people in upper and lower reaches along Lam Plai Mat as well as of proper implementation of the proposed Lam Plai Mat Sub-Project.

(5) The Fifth Plan indicates that there are three main problems in the 19 border amphoes areas as follows:

- The problem of rapid general deforestation and forest destruction in the watershed areas: The landless farmers or those who cannot produce enough for consumption from the nearby area and elsewhere have moved in and cleared the land for cultivation. The rate of encroachment-cum-settlement is as high as 6.1 per cent, resulting in the destruction of forest land of 5.28 million rai, or an average of 1.32 million rai per year between 1973 and 1977. Forest trees in watershed areas have inevitably been destroyed.

- The isolation of new communities and hence underdevelopment due to the uneven pattern of their settlements: They are also under the influence of insurgents from outside the country. The sporadic immigration to clear new land for cultivation has given rise to 318 new mubans in the past nine years. At present, there are altogether 1,786 mubans, with a population of 1.51 million. Of the total number of mubans, 95.8 percent have had their muban development committees appointed by the government, but there are only 45.5 percent of the mubans which have been trained to observe their rights and duties as citizens. Rural roads and water for human consumption, which are the government's main services are still inadequate. That is to say, 54.4 percent of the families are located more than 1 km away from rural roads. Families without adequate water supply for their own consumption and for their animals account for 30.7 percent of the total number of families. Education and public health services have not reached these mubans, particularly those near the border. The people in these communities hardly receive the benefits of economic development. Some of them have remained completely

underdeveloped. This weakness has paved the way for communist infiltration based in the Democratic Republic of Kampuchea. They have easy access to one another and have often cooperated in various terrorist activities in the past.

- Rapid expansion of land for field crops: The growing village communities which are mainly engaged in field crop production, are increasingly clearing more land for cultivation at a rate as high as 10.5 percent per year. The expansion in the use of land has had a direct negative impact on forest land which has been diminishing. Although the total crop yield has increased with a larger cultivable land area, the yield per rai of upland crops such as cassava, maize and jute has declined and is expected to fall further in the future.

(6) The government's target for development of the 19 border amphoes in the Lower Northeast is as follows:

- Target area:

This is a field crop land covering 1.40 million rai, which is further classified as:

(a) Principal target area, covering forest land in watershed areas inclusive of Lam Plai Mat, Lam Nang Rong, Lam Changhan, Lam Chi Noi and six others.

(b) Secondary target area, covering the rest of the land.

- Target groups: New communities in 318 mubans.

- Development measures:

(a) Conservation of forests in watershed areas in three types of forests in watershed areas, dense forests, and devastated forests.

(b) Speedy development and unification of new communities that are ready to counter insurgent threats from outside the country

° Community development
° Provision of potable water and water for other uses in deprived mubans
° Provision of compulsory education
° Provision of basic public health services

(c) Increase in efficiency of land use and land productivity to reduce land expansion:

° Research and promotion of main field crops
° Setting up of agricultural cooperatives and supporting industries
° Encouragement to sell agricultural products at a higher price. The government will encourage the establishment of local farm products market centres in the districts of Nang Rong, Prakhon Chai, Prasat, Sankha, Kantharalak, Khumkhan, Det Udom, Nam Yun, and Buntharik. The venture will be regulated so that both merchants and farmers will share the benefits. The government will keep only the minimum functions of providing basic facilities and ensuring a smooth functioning of the centres. A plan of road networks to join national highways with rural roads to the market centres will be drawn up and the construction promptly undertaken.

CHAPTER III THE PROJECT AREA

CHAPTER III. THE PROJECT AREA

3.1. Location and General Features

3.1.1. Geographical Location

The Project rea is located in the Lam Plai Mat and Lam Chi Noi basins, which are major tributaries of the Mae Nam Mun, and in the southernmost part of the Northeast Thailand near the Kampuchean border called as the "The Lower Northeast". The Lower Northeast corresponds to the drainage basin of the right bank of the Mae Nam Mun, one of the largest tributaries of the Mae Nam Khong.

(1) Lam Plai Mat Sub-Project

Lam Plai Mat Sub-Project is located in the Upper Lam Plai Mat basin. The dam and the reservoir are planned on the main stream of the uppermost reach of the Lam Plai Mat and the irrigation service area extends from the damsite to the place near Highway No.24 along both banks of the Lam Plai Mat. The Sub-Project area is accessible by Route 2119 (Pa Kham to Choke Chai via Soeng Sang).

(2) Nong Lum Puk Sub-Project

The Nong Lum Puk Sub-Project area is located in the basin of the Huai Nong Lum Puk, a tributary of the Lam Mat on the left bank near amphoe Soeng Sang. The damsite is located 2 km south of Route 2119 and can be reached by a feeder road. The irrigation service area is located immediate downstream of the damsite and extends to the center of amphoe Soeng Sang.

(3) Huai Phlu Sub-Project

The Huai Phlu Sub-Project area is located in the Huai Phlu sub-basin, a tributary of the Huai Seo in the Lam Chi Noi basin.

The damsite is located about 2 km north of Route 2075 (Pa Kham to Ban Kruat) and rather difficult to reach for lack of all-weather feeder road. The irrigation service area extends from the immediate lower stream of the damsite toward the confluence of the Huai Ta Kiew and the Huai Seo.

3.1.2. Administrative Division and Social Conditions

(1) Administrative Division of the Project Area

The administrative division of each sub-project area based on changwat, amphoe, and tambons as follows:

(a) Lam Plai Mat Sub-Project

Changwat	Amphoe	Tambon	No. of Muban Concerned
1. Nakhon Ratchasima	1. Soeng Sang	1. Non Sombun	6
		2. Sra Ta Khian	7
		3. Kut Bot	3
		Sub-total	16
2. Buriram	2. Pa Kham (King Amphoe)	4. Khok Mamuang	6
		5. Nong Bua	7
		6. Thai Charoen	10
		7. Pakham	13
		Sub-total	36
	3. Nang Rong	8. Chum Sang	8
		Total	60

i) The changwat boundary between Nakhon Ratchasima and Buriram is located about 30 km downstream of the proposed Lam Plai Mat damsite. A diversion weir called "Pa Kham" would be built on this boundary to serve existing paddy field in changwat Buriram.

ii) All the drainage basin at Lam Plai Mat damsite is administered by amphoe Soeng Sang. 558 households in the proposed reservoir have already been resettled under the "Development for Defense of the Boundary between Khon Buri-Soeng Sang Project" by the 2nd Army Command since October 1982. There are 324 resettled households immediately downstream the damsite, viz. 79 in Ban Rat Samaki on the left side and 136 in Ban Rat Burana and 109 in Ban Rat Charoen on the right side, while the remaining 234 households migrated to remote places for whom the said project bore the transportation cost of their housing properties. Each of the households near the dam was allocated 15 rai of upland field, and cultivation of their cassava fields in the reservoir area is permitted in the year 1983/84.

(b) Nong Lum Puk Sub-Project

Changwat	Amphoe	Tambon	No. of Muban Concerned
Nakhon Ratchasima	Soeng Sang	1. Kut Bot	2
		2. Soeng Sang	2
		Total	4

All the drainage basins at Nong Lum Puk damsite belongs to amphoe Soeng Sang. In the upper side of this drainage basin, there is a pond constructed recently under the rural job creation scheme which is outside the proposed reservoir area. In the proposed reservoir area, existing paddy field of 20 ha would have a land title of NOR SOR 3 as due compensation.

(c) Huai Phlu Sub-Project

Changwat	Amphoe	Tambon	No. of Muban Concerned
Buriram	Ban Kruat	1. Nong Mai Ngam	4
		2. Bung Charoen	5
		Total	9

i) All the drainage basins at the proposed damsite which is in amphoe Ban Kruat are designated as "Reserved Forest" and also "Military Area" related to Nikom Ban Kruat (self-help settlement program) which started some 30 years ago. Almost all of the proposed reservoir area is planted with cassava in the form of encroached public land; for this, no compensation should be officially required.

ii) History of tambon Nong Mai Ngam reveals that the first immigrants of about 50 years ago who spoke Thai in Korat style were criminals who escaped to hide themselves in the forest village. Another history of tambon Kao Khok indicates that the immigrants came from various parts of Thailand and even from Laos and Kampuchea. Afterward because of communist incursion, some of mubans were abandoned until the government gave them the land.

The Prime Minister's Office Notification No.5 (Jan. 1981) "Designation of Target Areas for Rural Development Programs under the Fifth Plan (1982-86)", has specified the target area for accelerated rural development including the following tambon and muban in the Sub-Project area.

Tambon	Muban
Nong Mai Ngam	1. Nong Mai Ngam
	2. Khok Wat
Bung Charoen	3. Bung Charoen
	4. Nong Pru
	5. Bung Kao

(2) Local Government Systems

Currently, the central government intends to strengthen the local administrative power through decentralization and deconcentration in order to accelerate the rural development and to govern the rural area more effectively.

Firstly, the administrative power is given to the field officials at changwat and amphoe. Secondly, the following local administrative units are established,

i) Changwat administrative organization
ii) Municipality (Tesaban) administrative organization
iii) Sanitary district administrative organization

Among the above three organizations, changwat administrative organization has various functions including the following three which are related to the components of the Project, together with public peace, provision of local elementary education, prevention and treatment of disease etc.

i) Provision and maintenance of water supply system
ii) Provision and maintenance of roads and waterways
iii) Provision and maintenance of drainage system

(3) Population and Social Conditions

(a) Population and Employment Opportunity

The whole sub-project area is classified into rural area in the "Population and Housing Census of National Central Office (NSO)". The 1983 population of muban in each Sub-Project, i.e. Lam Plai Mat, Nong Lum Puk and Huai Phlu is as follows:

Number of Households and Population (1983)

Sub-Project	Total Households	Total Population	Persons per House	Farm Households
1. Lam Plai Mat	8,730(100%)	49,390	5.6	7,630(87.4)
2. Nong Lum Puk	770(100%)	4,260	5.5	690(89.6)
3. Huai Phlu	960(100%)	5,390	5.6	810(84.7)
Total	10,460(100%)	59,040	5.6	9,130(87.3)

Source: Amphoe Offices concerned with Project Area.

The density and growth rate of population in the Project amphoe of sub-projects are shown below:

Density and Growth Rate of Population (1980)

Sub-Project	Area (km^2)	Population in 1982 (,000)	Density per km^2	Growth Rate from 1970 to 1980 (%)
1. Whole Kingdom	514,000	44,278	86	2.9
2. Northeast	170,220	15,461	91	2.9
3. Sub-Project (amphoe level)				
- Lam Plai Mat	3,767	256	68	6.2
- Nong Lum Puk	768	39	51	6.4
- Huai Phlu	553	52	94	7.1

Source: 1970 and 1980, Population Census (Amphoe Level).

The population growth rate in the Project Area is considerably high as compared with that of the Northeast and the whole of Thailand. This is because the overpopulation of farmers in the lower area along the Mae Nam Mun moved to the upper basin of its tributaries seeking new land and water resources.

In Buriram, the economically active population covers about 79 percent of the population of 11 years old and over and only two percent of the economically active population are looking for job. 93 percent of economically active population are engaged in agriculture of which about 55 percent are seasonally underemployed.

Agriculture in the Project Area is plagued with low productivity under rainfed conditions although employment opportunities are provided to some extent for farm labor at cassava and maize plantation in the concerned changwat. Recently, a large number of working people work outside the Project Area in the dry season after harvesting rice but also sometimes in the wet season, especially the drought years. The mubans in the downstream area of Pa Kham diversion weir (the Lam Plai Mat Sub-Project) are known for those working overseas like Saudi Arabia.

(4) Rural Water Supply and Other Infrastructure

(a) Rural Water Supply

The main source of rural water supply in the Project Area is rainfall in the wet season and shallow wells in dry season. The wells are usually located far away from houses and are commonly used collectively among villagers. The wells for drinking water which are different from those for domestic use are scarce in number and their water is almost exhausted in dry season. The distance from house to source of drinking water and other domestic-use water in the dry season is shown below:

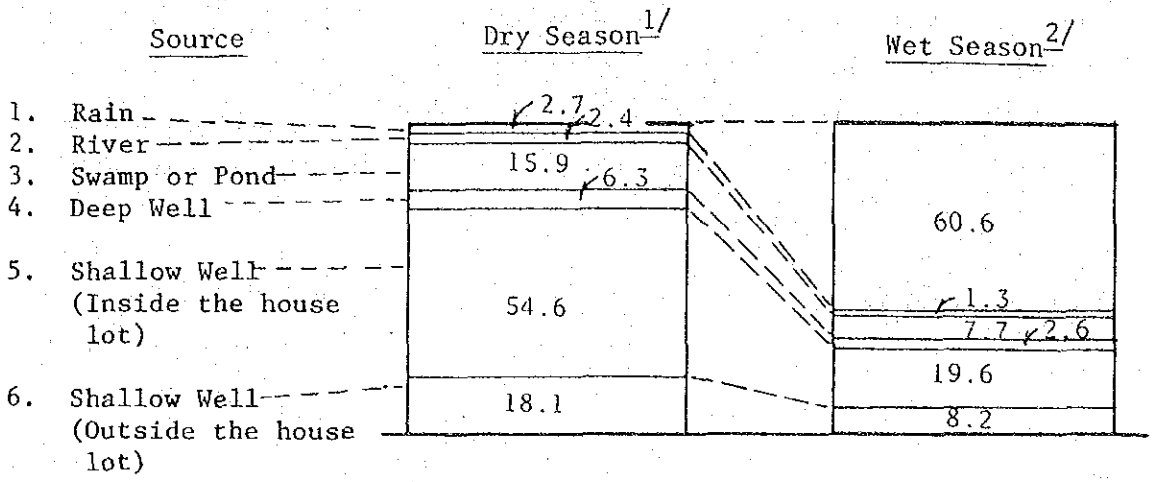
Water	Distance from House to Source
Drinking Water	Average 240 m, Maximum 1 - 1.5 km
Other domestic-use water	Average 190 m

Source: Farm Economic Survey conducted by Study Team.

The details of the water source by season are illustrated below:

Source of Rural Water Supply

(Unit: %, Total Water Supply = 100%)



Note: 1/ August to October
2/ February to April

Source: Farm Economic Survey conducted by Study Team, 1983.

(b) Rural Electrification

Available data indicate that 11 to 31 percent of the total villages in the Project amphoe and 9 to 17 percent of the total households had been electrified by 1982 as shown below:

Amphoe	No. of Electrified Muban (%)	No. of Electrified Households (%)
1. Soeng Sang	28.2	17.1
2. Nang Rong	10.8	15.3
3. Pa Kham	23.4	14.7
4. Ban Kruat	17.6	8.6

Source: Provincial Electricity Authority, 1982.

(c) Other Infrastructure

i) Road Networks

The changwat roads link the local urban centers of sub-projects, i.e. amphoe Soeng Sang, Pa Kham, Nang Rong and Ban Kruat. Except for the changwat roads between Pa Kham and Nang Rong, these are asphalted and connected to national highway No.24 and secondary highway No.224. Other road networks to promote communication between the said urban centers and villages have been constructed or are under construction under the direction of Accelerated Rural Development Office. The roads between villages and on-farm roads are very scarce and very poor in quality.

ii) Communication

Post, telegraph and telecommunication offices are located in changwat, amphoe and king amphoe. The inter-changwat communication service by post, telegraph and telephone is rendered on a 24-hour basis but such communication is limited among amphoe muang (provincial capital). Radio communication is for official use only, i.e. between changwat and amphoe.

iii) Public Health

Under the Ministry of Public Health, government hospitals are operated in each local urban center, and at tambon level there are health centers, midwifery offices, clinics and drug stores.

3.2. Physical Conditions

3.2.1. Topography and River Basin

The Project Area is located on the southern part of Khorat Plateau. The altitude of the Plateau ranges from 150 to 250 meters above mean sea level and the Project Area is bounded on the south by cuesta ridges of the San Kamphaeng Range, ranging from EL 300 m to EL 800 m.

Two river systems are developed in the Project Area. One is the Lam Plai Mat running from Mt. Khao Rai (EL 849 m) in the San Kamphaeng Range. The second is the Lam Chi Noi river originating in the cuesta ridges of the same range on the border of Kampuchea.

Lam Plai Mat and Nong Lum Puk Sub-Project areas are located in the Upper Lam Plai Mat basin while Huai Phlu Sub-Project area is located in the Upper Lam Chi Noi. The features of topography and river basin of each Project Area are as follows:

(1) Lam Plai Mat Sub-Project Basin

The Lam Plai Mat flows 40 km northeastward from the origin of the basin to amphoe Soeng Sang, then turns eastward running 20 km to king amphoe Pa Kham and finally flows northward to the lower part of the Lam Plai Mat in the vicinity of Highway No.24.

The slope of the river course is 1 to 77 from the origin to the damsite and 1 to 1,200 from the damsite to the point near the Highway No.24. The alluvial plain has the river width of about 2 km, the traverse slant of the river course is about 1 to 1,000, and the slope of both hillsides is 1 to 10 to 1 to 300.

The existing farm land in the Sub-Project area spreads mostly in the alluvial plain and hillside along the river course. The existing paddy fields which are developed in the alluvial plain are about 19,000 ha corresponding to 12 percent of the total drainage area (1,581 sq.km) at M82 Station and are mostly under the rainfed cultivation of wet season paddy.

The drainage basin of 485 sq.km at the proposed damsite is divided into two sub-basins: the Lam Plai Mat and the Huai Sai Kong. The former sub-basin is formed by a steep mountain range with a drainage area of 241 sq.km at elevation of EL 49 m to EL 235 m while the latter is formed by a flat valley area with a drainage area of 244 sq.km at elevation EL 370 m to EL 235 m and covered mostly with rough forest. Part of the river course of the Upper Huai Sai Kong is not clear.

(2) Nong Lum Puk Sub-Project Basin

The Huai Nong Lum Puk is a small tributary of the Upper Lam Plai Mat basin, originating from the western mountain range at about EL 300 m and flowing north of muban Soeng Sang. It meanders for about 15 km southwestward to join the mainstream of the Lam Plai Mat at its left bank.

The river bed gradient is 1 to 158 from the origin of the basin to the proposed damsite and 1 to 350 from the damsite to the confluence with the Lam Plai Mat. The river course is not clear. The flood floor is about 200 m wide, and the traverse slant is about 1 to 1,000. The slope of both hillsides is 1 to 40 on an average.

The existing paddy field spreads all over the flood floor and its area is about 200 ha corresponding to five percent of the total drainage area (37 sq.km) at the confluence with the Lam Plai Mat.

The drainage area of 25 sq.km at the proposed damsite is covered mostly with thin forest except for paddy fields and cassava fields along the river course.

(3) Huai Phlu Sub-Project Basin

The Huai Phlu is a tributary of the Huai Ta Kiew which joins the Huai Seo, the tributary of the Lam Chi Noi. The Huai Phlu originates in the Sam Kamphaeng mountain range of about EL 550 m and flows about 12 km northwestward to the proposed damsite, and then takes its course northeastward for about 9 km to join the Huai Kiew. After that, the Huai Ta Kiew flows down about 3 km northward joining the Huai Seo.

The slope of the river course is 1 to 130 from the origin to the proposed damsite and 1 to 370 from the damsite to the confluence of the Huai Seo. The flood floor of the alluvial is about 400 m wide and the slope of both hillsides is 1 to 40.

The existing paddy fields with about 600 ha extends over the plain, and the downstream part of the paddy fields is connected to the basin of the Huai Seo. Ratio of the paddy field area to the total drainage basin (170 sq.km) at the confluence of Huai Seo is 3.5 percent.

The drainage area of 21 sq.km at the proposed damsite is covered mostly with rough forest and no paddy fields.

3.2.2. Meteorology and Hydrology

(1) Meteorology

The Project Area is subject to the tropical monsoon climate of Southeast Asia. The southwest monsoon (mid-May to September) blows out of the Indian Ocean often with heavy rains, while the northeast

monsoon (November to February) from the Chinese Continent brings about a long spell of drought. Two transitional periods are called the retreating southwest monsoon period in October (cool) and the retreating northeast monsoon period in March to May (hot).

The southwest monsoon carries moisture-laden air northeastward and across the Khorat Plateau. It does not bring continuous rain to the area. The monsoon rainfall consists primarily of localized showers with frequency, concentration and intensity depending upon time and progress of the season.

Meteorological observations have been made by the Meteorological Department (MD) and Royal Irrigation Department (RID) in this region. The latter authority has distributed a number of observation stations over the region mainly to observe rainfall. Climatological data in Nakhon Ratchasima are adopted representing the climate of the Project Areas and are compiled in Table A-1-1 of ANNEX A.

For this study, reference crop evapotranspiration (ETo) is computed according to the modified Penman method as recommended by FAO (1977), using the Nakhon Ratchasima climatological data:

Unit	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
mm/day	3.8	4.4	5.3	5.3	4.5	4.2	4.0	3.7	3.4	3.9	3.9	3.7	-
mm/mo.	118	123	164	159	140	126	124	115	102	121	117	115	1,524

(2) Hydrology

Rainfall, river runoff, and flooding relevant to the Project are described below:

(a) Rainfall

A number of the rain and runoff gauges are located in and near the Project Area as shown in Figure A-1-1 of ANNEX A. In the hilly and mountainous regions where the proposed Sub-Projects are situated, very few gauges are available, thus it is rather difficult to grasp the areal rainfall of the drainage area of the proposed damsites for the estimation of the river discharge.

i) Annual and Monthly Areal Rainfall

The long-term areal rainfall has been estimated on a daily basis mainly by the available daily record of the stations nearby the Project. The average annual and monthly rainfall of each Sub-Project for 30 years (1952-1981) is summarized below:

(Unit: mm)

Sub-Project	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Total Annual	Total May to Oct
Lam Plai Mat & Nong Lum Puk [1/]	82	153	103	121	118	227	151	35	3	3	16	55	1,065	872
Huai Phlu [2/]	78	160	170	165	171	305	172	31	2	5	25	29	1,312	914

Note: 1/ Utilized rainfall gauge for the estimation
- Soeng Sang, Lam Sae, Ban Raboh Hua Kwang, Nang Rong Dam and Khon Buri.

2/ - ditto -
- Lam Pathia, Nakhon Ban Kruat, Lahan Sai and Nang Rong.

A noticeable feature of rainfall in the Project Area is the lack of its correlation at different gauges, showing that on the daily basis one gauge may have heavy rainfall, but another nearby none. Even on a seasonal or annual basis, the rainfall correlations are still poor.

Particular attention is paid to the dry periods which frequently occur in June or July normally lasting 15 to 20 days. It has been said that the Lam Plai Mat and Nong Lum Puk sub-basins have suffered from shortages in water and the Huai Phlu sub-basin has often suffered from the influence of heavy rainfall caused by the tropical depression.

Moreover, it could be interpreted that the difference in areal rainfall as shown above is strongly connected with the difference in agricultural productivity, particularly for the wet season paddy in the sub-basins. This means that the Huai Phlu sub-basin would have a more favorable environment in terms of agriculture as compared with the Lam Plai Mat and Nong Lum Puk sub-basins.

ii) Daily Rainfall

The frequency analysis of the daily rainfall records is normally required for the investigation of floods for designing the spillways of the storage dams and weirs.

In representing rainfall stations, Lam Sae for the Lam Plai Mat and Nong Lum Puk Sub-Projects, and Lahan Sai for the Huai Phlu Sub-Project have been selected. The adopted design rainfalls for each Sub-Project are as follows:

Adopted Maximum One-day Rainfall

(Gumbel's method)

(Unit: mm)

Sub-Project	Return Period (yrs.)							
	5	10	20	50	25	100	200	500
Lam Plai Mat & Nong Lum Puk	100	115	131	136	151	166	188	201
Huai Phlu	112	135	159	166	188	210	231	260

iii) Hourly Rainfall

In order to estimate the peak flood for the dams of each Sub-Project and for the diversion weir which is included in the Lam Plai Mat Sub-Project, the hourly data at Nang Rong rainfall station are analyzed and the following equation has been derived from the plots of rainfall depth and rainfall duration using the least square method:

$$Rt = 0.6368 \times R24 \times t^{-0.858}$$

where Rt : rainfall intensity for any duration (mm/hr)

R_{24} : maximum one-day rainfall (mm)

t : duration of rainfall (hr)

(b) River Runoff

i) River Runoff Observed

Observed river runoff records are compiled on water year basis from April to March in Table 3-2-1.

ii) Rainfall-Runoff Relation

Annual runoff coefficients with areal rainfall at four runoff gauges are shown in Table 3-2-2 and are summarized as follows:

Station	Drainage Area (sq.km)	Average Annual Rainfall (mm)	Average Annual Runoff (MCM)	Average Annual Runoff Coefficient (%)	Observed Period of Runoff
M81A	442	1,233	178	32.7	1970-1980
M82	1,581	1,252	122	6.2	1969-1971
M86	280	1,058	22	7.6	1969-1971
M93	329	1,253	50	12.1	1978-1982

It should be noted that the runoff coefficients at M81A are surprisingly high as compared with 1,233 mm of the average annual rainfall and also with the runoff coefficients in other gauges.

Table 3-2-1 Annual Runoff and Runoff Depth

Station	M81A	M121	M82	M86	M93
D.A (sq.km)	442	485	1,581	280	329
1. Annual Runoff (MCM)					
Water Year					
1969	-	-	123	31	-
1970	100	-	148	22	-
1971	143	-	96	14	-
1972	311	-	-	-	-
1973	110	-	-	-	-
1974	172	-	-	-	-
1975	260	-	-	-	-
1976	223	-	-	-	-
1977	122	-	-	-	-
1978	216	-	-	-	54
1979	114	-	-	-	13
1980	189	-	-	-	111
1981	-	-	-	-	11
1982	-	-	-	-	62
1983	(213) 1/	(63) 2/	-	-	(105) 1/
Average 3/	178	-	122	22	50
2. Annual Runoff Depth (mm)					
Water Year					
1969	-	-	78	111	-
1970	226	-	94	79	-
1971	323	-	61	51	-
1972	704	-	-	-	-
1973	249	-	-	-	-
1974	389	-	-	-	-
1975	588	-	-	-	-
1976	505	-	-	-	-
1977	276	-	-	-	-
1978	488	-	-	-	164
1979	257	-	-	-	40
1980	427	-	-	-	337
1981	-	-	-	-	34
1982	-	-	-	-	187
1983	(482) 1/	(131) 2/	-	-	(320) 1/
Average 3/	403	-	78	80	152

Notes: 1/ Runoff from Apr. to Oct.
2/ Runoff from Jul. to Oct.
3/ Up to 1982

Table 3-2-2 Areal Rainfall and Annual Runoff Coefficient

Station	M81A	M121	M82	M86	M93
DA (sq.km)	442	485	1,581	280	329
1. Areal Rainfall (mm)					
Water Year					
1969	- 1/	-	1,256.6 2/	1,098.6 3/	-
1970	1,586.1	-	1,318.1	1,115.1	-
1971	1,239.9	-	1,181.2	961.2	-
1972	1,141.3	-	-	-	-
1973	1,070.5	-	-	-	-
1974	1,264.1	-	-	-	-
1975	1,231.2	-	-	-	-
1976	1,353.9	-	-	-	-
1977	1,300.6	-	-	-	- 4/
1978	1,194.4	-	-	-	1,255.1
1979	810.2	-	-	-	1,009.6
1980	1,371.3	-	-	-	1,797.2
1981	-	-	-	-	966.6
1982	-	-	-	-	1,236.2
Average	1,233.0	-	1,252.0	1,058.3	1,252.9
2. Annual Runoff Coefficient (%)					
Water Year					
1969	-	-	6.2	10.1	-
1970	14.2	-	7.1	7.1	-
1971	26.1	-	5.2	5.3	-
1972	61.7	-	-	-	-
1973	23.3	-	-	-	-
1974	30.8	-	-	-	-
1975	47.8	-	-	-	-
1976	37.3	-	-	-	-
1977	21.2	-	-	-	-
1978	40.9	-	-	-	13.1
1979	31.7	-	-	-	4.0
1980	31.1	-	-	-	18.8
1981	-	-	-	-	3.5
1982	-	-	-	-	15.1
Average	32.7	-	6.2	7.6	12.1

Notes: 1/ Areal rainfall = Lam Sae (0.78) + Huai Samong (0.13) + Lam Phyathan (0.09)

2/ Areal rainfall = Nang Rong (0.15) + Lahan Sai (0.27) + B. Raboh Hu Kwang (0.16) + Lam Sae (0.42)

3/ Areal rainfall = Khon Buri (0.40) + Nang Rong (0.60)

4/ Areal rainfall = Lam Pathia (0.41) + Nikhom Ban Kruat (0.59)

A new runoff gauging station of the Lam Plai Mat at M121 was installed just before the field work of the Feasibility Study and the runoff data with the other adjoing basins during the period from August to October in 1983 are shown in Table 3-2-3 and summarized as follows:

Basin	Drainage Area (sq.km)	Rainfall (mm)	Runoff Yield (mm)	Runoff Coefficient (%)
Lam Sae	422	968	482	50
Lam Plai Mat	485	742	131	18
Nang Rong Dam	450	907	324	36
Huai Seo	329	896	287	32

As is clear in the above table, the runoff of the Lam Plai Mat presents considerably low value as compared with the other adjoing basins.

This is considered to be determined by not only rainfall amount but characteristics of the drainage area. The physiographic features of the Lam Plai Mat drainage area are carefully studied.

The Lam Plai Mat damsite is drained by two major tributaries, the Lam Plai Mat main stream and Huai Sei Kong, covering 241 and 244 sq.km, respectively.

The following physiographic characteristics of both tributaries can be pointed out by a map of scale 1:50,000 and the landsat false-color imageries. Erosive forms on the Lam Plai Mat main basin, west half of the drainage area, is characterized physiographically by well-eroded and widely extended river channel, and outcrops of alluvial deposits on the river channel.

Erosive forms on the Huai Sai Kong, especially along the river channels are so gentle and moderate in comparison with the west

Table 3-2-3. Areal Rainfall and Runoff for the Basins in and Near Project Area

Basin	D.A. (sq.km)	Item	Aug. 1983 1 (mm)	Aug. 1983 2 (mm)	Aug. 1983 3 (mm)	Sep. 1983 1 (mm)	Sep. 1983 2 (mm)	Sep. 1983 3 (mm)	Oct. 1983 1 (mm)	Oct. 1983 2 (mm)	Oct. 1983 3 (mm)	Total (Aug. to Oct.) (mm)	Runoff Coefficient (%)
Lam Sae (M81A)	442	Areal Rainfall	140	106	43	144	29	206	151	136	13	968	50
		Runoff	24	34	49	28	22	38	74	165	48	482	
Lam Plai Mat (M121)	485	Areal Rainfall	82	61	30	89	58	139	88	166	29	742	18
		Runoff	2	2	6	8	8	12	20	79	31	131	
Nang Rong Dam	450	Areal Rainfall	133	125	26	47	142	118	103	198	21	907	36
		Runoff 3/	19	4	8	36	16	17	46	153	25	324	
Huai Seo (M93)	329	Areal Rainfall	121	91	18	93	131	158	134	123	28	896	32
		Runoff	9	20	23	6	18	18	40	129	24	287	

1/ 1, 2, 3 : Early, Middle and End of each month.

2/ Thissen Weight

Lam Sae : Lam Sae (0.75) + M121 (0.03) + Huai Samong (0.14) + Lam Phyathan (0.08)
Lam Plai Mat : M121 (0.84) + Nang Rong Dam (0.07) + Ban Raboh Hu Kuang (0.06) + Lam Sae (0.03)
Nang Rong Dam: Nang Rong Dam (0.72) + M121 (0.24) + Ban Raboh Hu Kwang (0.02) + Ta Phraya (0.02)
Huai Seo : Lam Pathia (0.41) + Nikhom Ban Kruat (0.59)

3/ Runoff was estimated on the basis of observed mean daily reservoir stage.

half of the drainage area that it is slightly difficult to judge a direction of flow. Dense forest covers the undulated slope and valley and only a lined sparse and tall trees can be found on the exact location of the channel. No alluvial deposit can be observed along the channel.

According to the Geological Map "Nakhon Ratchasima", 1:250,000, published by DMR, the basin of the Lam Plai Mat damsite can be divided into three physiographic zones as follows:
(see Figure B-2-1 and Figure B-2-2, ANNEX B)

- Zone I is mainly underlaid by quartzose sandstone and characterized by a steep and well eroded valley slope with a broad channel floor.

- Zone II is mainly underlaid by siltstone, and coarse and conglomeratic sandstones. It is characterized by an undulated hill and undefined valley.

- Zone III is mainly underlaid by conglomeratic sandstone and is characterized by a conspicuous ridge with a steep cliff on its northeastern slope.

These differences in physiographic and geologic features between the Huai Sai Kong and the Lam Plai Mat sub-drainage areas have influence on the hydrological aspect. The field observation of discharge at both drainage basins performed in this study indicates the following:

Sub-basin	Drainage Area		Discharge Observed		Specific Discharge	
	(sq.km)	(%)	(cu.m/s)	(%)	(cu.m/s/sq.km)	(Rate)
Lam Plai Mat	241	49.5	5.66	63.8	0.0235	1.00
Huai Sai Kong	244	50.5	3.21	36.2	0.0132	0.56
Total	485	100.0	8.87	100.0	0.0183	0.78

This fact means that the specific discharge from the basin of the Huai Sai Kong is about 50 percent of the Lam Plai Mat sub-basin. It is considered that part of the rainfall would be retained in the drainage basin and discharged outside of the drainage area as groundwater flow.

Furthermore, sandstone exposed in the upper part of the Huai Sai Kong plays a most important role for discharge i.e., the rainfall infiltrates into the heavily weathered layer of sandstone without any severe flows to the river channel.

The rainfall during the period of May to August would be completely absorbed into the ground and paddy fields (about 150 mm of storage capacity). Due to this absorption and because highly intensive rainfall over a large area is relatively rare early in the wet season, peak runoff would occur almost exclusively during the period of September to October and early November. In November, the runoff sometimes exceeds the rainfall and this comes partly from the release of water from the paddy fields before harvesting.

iii) Special Note on the Runoff Observed at the Lam Plai Mat Damsite

iv) Runoff Analysis

The direct runoff measurement on a long term basis at the three proposed damsites is not available to date. Under this critical situation, the runoff at the three proposed damsites has been synthesized by establishing the proper runoff model and then applying a basin-wide areal rainfall to that model. In this study, 10-day runoff on the basis of daily rainfall has been reconstructed.

For the development of the runoff model, a runoff gauge is selected for each sub-basin considering two factors, i.e., its location for the subject sub-basin and the similarity of basin characteristics such as vegetation, topography and geology. Adopted runoff gauges are shown below:

Proposed Damsite	Type of Runoff Model	Adopted Runoff Gauge	Period of Observation
Lam Plai Mat (DA = 485 sq.km)	Multiple Regression	Lam Plai Mat (M121) (DA = 485 sq.km)	Aug. to Oct. 1983
Nong Lum Puk (DA = 25 sq.km)	Tank Model	Lam Sai Yong (M86) (DA = 280 sq.km)	1969 to 1971
Huai Phlu (DA = 21 sq.km)	Tank Model	Huai Seo (M93) (DA = 329 sq.km)	1978 to Oct. 1983

Among the three selected runoff gauges, the drainage area at M121 of the Lam Plai Mat which is located at the proposed damsite has no paddy field, and the developed runoff model by the multiple regression method is directly applied to the estimation of long-term runoff at the damsite. Estimated runoff for the observed period is shown by hydrograph in Figure A-3-1 and summarized in Table 3-2-4.

While the other basins of two runoff gauges, M86 and M93 have paddy field areas, runoff models of these basins have been developed following two steps.

Step 1 : Development of a tank model with the effects of a paddy field area.
This model consists of two row tanks, one row tank indicates the runoff-structure of the mountainous area and the other one shows the paddy field area as given in Figure A-3-1 and Figure A-3-2, ANNEX A.

Step 2 : Development of a tank model without the effects of a paddy field area.
This model can be obtained by removing second row tank from the developed tank model in Step 1.

The estimated runoffs using the tank model developed in Step 1 are shown by hydrographs in Figure A-3-4 and Figure A-3-5, ANNEX A and summarized in Table 3-2-4.

As seen in the table, for the observation period there is not much difference in estimated and observed averages. However, error is more significant by year. The reason for such difference is considered insufficient information on areal rainfall.

Thus, long-term runoff at each damsite by developed runoff model has been produced on a daily basis, the annual and monthly runoff at each proposed damsite is tabulated in Table 3-2-5 and is summarized as follows:

Sub-Project	Average Rainfall (mm)	Annual Runoff (MCM)	Annual Runoff Coefficient (%)
Lam Plai Mat	1,064.5	77.4	15.0
Nong Lum Puk	1,064.5	4.4	16.4
Huai Phlu	1,312.1	4.6	16.7

v) Flood Discharge Analysis

Based on the rainfall record, the flood analysis has been made by using the Snyder method. Return period of the designed rainfall in accordance with the types of structure is adopted based upon RID's Criteria.

	Return Period (years)
Storage Dam	500
Diversion Weir	50

Table 3-2-4 Summary of Error Evaluation of Runoff Model

(Unit: mm)

Description	Water Year 1983 Aug.	Sep.	Oct.	Total
Lam Plai Mat (DA = 485 sq.km)				
Estimated Runoff (Qe)	9.5	34.7	128.5	172.7
Observed Runoff (Q)	10.4	28.1	130.5	169.0
Error (Qe/Q)	0.91	1.23	0.98	1.02

Lam Sai Yong (DA = 280 sq.km)	Water Year 1969	1970	1971	Average
Estimated Runoff (Qe)	122	63	57	80.7
Observed Runoff (Q)	111	79	51	80.3
Error (Qe/Q)	1.10	0.80	1.12	1.00

Huai Seo (DA = 329 sq.km)	Water Year 1978	1979	1980	1981	1982	1983	Average
Estimated Runoff (Qe)	156	77	304	34	165	331	177.8
Observed Runoff (Q)	167	40	336	34	187	320	180.7
Error (Qe/Q)	0.93	0.93	0.90	1.00	0.88	1.03	0.98

Table 3-2-5 Summary of Runoff at Proposed Damsite

1. Lam Plai Mat	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Total
Monthly Average Runoff (MCM)	2.3	11.0	6.8	7.6	4.9	21.1	19.0	2.2	0.1	0.1	0.2	2.0	77.4
Monthly Average Runoff Depth(mm)	4.7	22.7	14.1	15.6	10.0	43.5	39.1	4.6	0.3	0.3	0.4	4.2	159.6
Annual Runoff Coefficient (%)													15.0
2. Nong Lum Puk													
Monthly Average Runoff (MCM)	0.08	0.50	0.26	0.37	0.35	1.26	1.23	0.23	0.02	0.01	0.01	0.06	4.37
Monthly Average Runoff Depth(mm)	3.0	20.0	10.3	14.6	14.0	50.2	49.2	9.1	0.7	0.2	0.3	2.5	174.7
Annual Runoff Coefficient (%)													16.4
3. Huai Phlu													
Monthly Average Runoff (MCM)	0.10	0.34	0.45	0.50	0.41	1.35	1.16	0.13	0.03	0.03	0.05	0.06	4.61
Monthly Average Runoff Depth(mm)	4.6	16.4	21.6	24.0	19.7	64.2	55.1	6.1	1.3	1.2	2.2	2.8	219.4
Annual Runoff Coefficient (%)													16.7

The estimated peak discharge of flood flow for each structure is shown in Table A-4-4 in ANNEX A and is summarized as follows:

Structure	DA (sq.km)	Peak Discharge (cu.m/s)	Peak Discharge (cu.m/s/sq.km)
Lam Plai Mat Dam	485	1,366	2.82
Nong Lum Puk Dam	25	135	5.40
Huai Phlu Dam	21	140	6.67
Pra Kham Diversion Weir	1,048	1,067	1.02

The above estimated peak discharge is prepared based on the daily rainfall data at the Lam Sae and the Lahan Sai gaging stations located in the nearby basins of the Project Area. The more accurate peak discharge for spillway design will be estimated in the future detail design stage, by the newly established gaging station in the Project Area. The estimated peak discharge has been compared with envelope curve based on the estimated design flood of other dams in Thailand, as shown in Figure A-4-1, ANNEX A. The estimated peak discharges are close to this envelop curve.

(c) Sediment Transport

Based on the collected data, the sediment yield of 150 cu.m per sq.km per year has been taken from three reservoirs, and the low water level of an effective reservoir capacity has been set up with allowance of sediment storage for 100 years.

(d) Water Quality

Water quality in the river runoff was inspected for irrigation and drinking water at the three sites near the damsite of each sub-project.

No problems were found in usage for irrigation. While for drinking purposes, the concentration of total iron of surface water is in excess of the upper limit of the maximum acceptable value by WHO. In the proposed drinking water supply, water is stored in the proposed Muban Pond, and then it will be drawn up from the proposed

shallow well adjacent to the above pond. Therefore, the iron could be absorbed by percolation through soil to some extent and if the iron concentration is still more than the acceptable value, the water should be used after boiling.

3.2.3. General Geology and Seismology

(1) General Geology

Three distinctively different sequences of geologic units underlie the Project Area. One sequence is a basement of the plateau called the Khorat Group, which ranges in age from the Lower Jurassic to the Upper Cretaceous comprising only slightly deformed non-marine sedimentary beds of conglomerate, sandstone, siltstone, claystone and shale. The second sequence is basalt which is extruded at the tertiary, overlying the Khorat Group as an erosive remnant. The remnant of basalt caps a few ridges and low hills on the middle stream of the Project Area. The third sequence is the quaternary formation comprising of thin deposit of terrace, extremely variable in thickness of alluvial deposit, and slope detritus.

These sequences except the quaternary formation are not exposed at the surface on the middle and lower river basins; however, a few outcrops of the Khorat group are exposed at the hilly mountains on the upper part of the Lam Plai Mat and Lam Chi Noi.

(2) Seismology

According to the seismological report on Thailand's seismic activities compiled by the Network Headquarters Studies and the Research Division of the Meteorological Department during 1975 to 1983, earthquakes in Thailand originate in the center of the north and the magnitude ranges from three to five. Most of the earthquake epicenters are located in Northern Thailand. There are no earthquake epicenters observed in the Northeast region. Majority of earthquake occurs in the neighboring countries.

The coefficient (K = 0.05) of seismic force for the design was decided by using the maximum acceleration based on the data observed during the period of 1975 to 1983 as shown in ANNEX F.

3.2.4. Soils and Land Classification

- Landform

The Project Area is situated in the Korat Plateau whose surface is gently undulating with lowhills and numerous streams of the river system of Mae Nam Mun. The principal landforms in the area are flood plains, low terraces, and middle to high terraces. The flood plains are nearly flat, low-lying lands which extend in parallel to the river course. Most of these lands consist of the active flood plain surfaces which are inundated frequently by the overflow of river water during the wet season. The low terraces are located between the flood plains and middle terraces and are subject to the natural flooding only when the runoff is exceptionally high during the wet season. The middle to high terraces form the side slopes of the valley and have nearly level or gently sloping reliefs.

- Soils

The soils prevailing in the area have been formed of recent or old alluvium under the Tropical Savanna climate. Detail soil map covering the area of the three Sub-Projects are compiled in ANNEX C. The soil series found in these areas are summarized in Table 3-2-6.

The soils of the flood plains are Hydromorphic Alluvial soils originated from the recent or semi-recent riverine alluvial deposits by annual floods. They are deep and commonly have fine texture such as silty clay loam, silty clay, and clay throughout the profile. They have relatively high natural fertility and have been used for paddy rice cultivation with a satisfactory yield when flooding is not destructive.

Table 3-2-6. Summary of Soil Classification

Landform	Mapping Number	Mapping Unit Name	Project Study Area			
			Upper Lam Plai Mat		Huai Seo	
			rai	%	rai	%
Flood Plain	1	Alluvial Complex	3,700	3.1	-	-
	2	Chiang Mai	1,180	1.0	-	-
	3	Patchaburi	7,910	6.7	-	-
	4	Phimai	810	0.7	-	-
	5	Wathana	1,400	1.2	-	-
		Sub-total	(15,000)	(12.7)	(-)	(-)
Lower Terrace	6	Roi Et	34,180	29.1	6,890	16.9
	7	Roi Et Loamy variant	10,880	9.2	3,820	9.4
	8	Roi Et clayey variant	70	0.1	-	-
		Sub-total	(45,130)	(38.4)	(10,710)	(26.3)
Middle Terrace	9	That Phanom	500	0.4	-	-
	10	Ubon	200	0.2	-	-
	11	Renu	15,490	13.2	2,480	6.1
	12	Korat	31,230	26.6	26,680	65.3
	13	Phon Phisai	1,030	0.9	-	-
	14	Nam Phon	540	0.5	460	1.1
	15	Rio Et/Korat association	340	0.3	-	-
		Sub-total	(49,330)	(42.1)	(29,620)	(72.5)
High Terrace	16	Satuk	4,650	4.0	380	0.9
	17	Warin	390	0.3	-	-
	18	Korat/Satuk	-	-	-	-
		Sub-total	(5,040)	(4.3)	(380)	(0.9)
Dissected Erosion Surface & Hills	19	Buri Ram	250	0.2	-	-
	20	Burin	2,490	2.1	-	-
		Sub-total	(2,740)	(2.3)	-	-
Others			260	0.2	140	0.3
Total			117,500	100.0	40,850	100.0

The soils of low terraces are Low Humic Gley Soils which have developed on older alluvial deposits under poorly drained condition. They have formed well developed A and B horizons and the texture of A horizon is usually loamy and that of B horizon ranges from sandy clay loam to clay. Practically, all of the soils prevailing on low terraces are used for transplanted paddy rice cultivation.

In the middle terraces, the soils are predominantly Gray Podzolic Soils and Low Humic Gley Soils. The natural vegetation on these soils is mainly brush or low open dipterocarp aceous forest. Paddy is also grown in a few places where rain water can be collected, and upland crops such as cassava, maize and kenaf are grown on better drained soils.

In the high terraces, on the other hand, the soils are Red-Yellow Podzolic Soils which have originated from unconsolidated old alluvium under somewhat well drained condition. Having undergone considerable weathering and leaching after the deposition of the coarse-texture sediment a long time ago, these soils are of low natural fertility. Most lands are covered by low open forests but upland crops are cultivated on partially cleared lands.

The soils on the dissected erosive surface are distributed in the fringe of the area with higher elevation, therefore, these colluvium and residuum soils are insignificant in their extent within the irrigable area by the Project.

- Land Classification

In accordance with the land classification specifications for irrigated paddy which have been made especially for this Project, the lands have been classified into four land classes, that is, Classes R1, R2, R3, and R6. The land classification maps are explained in ANNEX C. The area of each land class is summarized in Table 3-2-7.

- Land Use Categories

Because of insufficient water resources to cover entire arable lands, the Project has been envisaged to provide irrigation water only to the lands on flood plains and low to middle terraces which are presently used for paddy cultivation under mainly rainfed or partially located irrigation systems. Therefore, the present land use categories were surveyed in order to select the service area and to set up the canal alignment. Table 3-2-8 is a summary of the present land use categories in the Study areas.

Table 3-2-7 Summary of Land Classification

Land Class	Project Study Area				Irrigable Area by Sub-Project							
	Upper Lam Plai Mat		Husai	Seo	Lam Plai Mat				Nong Lam Phuk		Huai Phlu	
					Upper	Lower	Total					
	rai	%	rai	%	rai	rai	rai	%	rai	%	rai	%
R1	8,720	7.4	1,490	4.2	1,231	1,470	2,701	4.0	603	27.7	889	16.8
R2s	29,590	25.2	13,450	38.3	5,267	12,952	18,219	27.1	232	10.7	2,789	52.7
R2st	30,240	25.7	260	0.7	5,151	16,027	21,178	31.5	834	38.4	163	3.1
R2sd	960	0.8	210	0.6	-	4,649	4,649	6.9	-	-	-	-
R2std	8,180	7.0	-	-	-	54	54	0.1	-	-	-	-
Sub-total	(68,970)	(58.7)	(13,920)	(39.6)	(10,418)	(33,682)	(44,100)	(65.6)	(1,066)	(49.1)	(2,952)	(55.8)
R3s	5,250	4.5	4,210	12.0	-	2,946	2,946	4.4	505	23.2	223	4.2
R3st	19,570	16.7	6,210	17.6	1,628	14,443	16,071	23.9	-	-	842	15.9
Sub-total	(24,820)	(21.2)	(10,420)	(29.6)	(1,628)	(17,389)	(19,017)	(28.3)	(505)	(23.2)	(1,065)	(20.1)
R6st	11,190	9.5	7,860	22.4	1,268	121	1,389	2.1	-	-	388	7.3
Others	3,800	3.2	1,470	4.2								
Total	117,500	100.0	35,160	100.0	14,545	52,662	67,207	100.0	2,174	100.0	5,294	100.0

Table 3-2-8. Summary of Land Use Categories

Land Use Category		Mapping Symbols	Project Study Area: Upper Lam Plai Mat Sub-Basin rai	Upper Lam Plai Mat Sub-Basin %	Huai Seo Sub-Basin rai	Huai Seo Sub-Basin %
Crop Field Rice						
	- Transplanted	Rt	26,150	22.3	11,220	31.9
	- Broadcasted	Rb	4,390	3.7	-	-
	Cassava	Cv	5,120	4.4	7,750	22.0
	Maize	Co	1,100	0.9	-	-
	Jute	Ju	790	0.7	310	0.9
	Sugarcane	Sc	-	-	-	-
Natural Vegetation	Shrubs	Sh	2,150	1.8	50	0.2
	Trees	Tr	210	0.2	-	-
	Termite mounds with trees	Tm	-	-	-	-
Combination Land Use	Partially cleared crop field	Rt/Sh	3,140	2.7	-	-
		Rt/Tr	5,090	4.3	1,670	4.7
		Rb/Sh	7,060	6.0	-	-
		Cv/Sh	5,460	4.6	-	-
		Cv/Tr	530	0.5	-	-
		Co/Sh	1,560	1.3	-	-
		Cv-Co/Tr	570	0.5	-	-
	Complex land use	Rt-Tm	47,120	40.1	11,790	33.5
		Cv-Co	370	0.3	-	-
		Cv-Ju	1,040	0.9	160	0.5
		Cv-Sc	-	-	440	1.3
		Cv-Sc-Ju	-	-	180	0.5
		Sh-Tr	1,850	1.6	120	0.3
Other Land Use	Village complex	Village	3,230	2.7	1,190	3.4
	Ponding, swamp area	Nong	570	0.5	280	0.8
Total			117,500	100.0	35,160	100.0

Source: Land Classification Branch, Soil & Geology Div., RID (November 1983)

3.3. Present Agriculture

3.3.1. Land Use and Tenure

(1) Land Use

The statistical data on the present land use in the Project muban in each Sub-Project area are summarized in Table 3-3-1, which indicate the following (For further detail, see ANNEX D:)

(a) The arable area in 1982 for each sub-project of Lam Plai Mat, Nong Lum Puk and Huai Phlu was expanded, respectively, by about 1.7 times, 1.3 times and 4.1 times as much as the respective area in 1977. Especially, the upland field area was increased in each Sub-Project area through conversion of forest land to upland field.

(b) The paddy field area per farm household in 1982 decreased or remained the same in comparison with that in 1977 except for Huai Phlu Sub-Project, but the respective upland field area remained almost the same.

This means that the possibility of developing additional paddy fields is limited for the farmers. On the other hand, the forest land in 1982 had been diminished to only 16 percent and 7 percent of the total area in changwat Nakhon Ratchasima and Buriram, respectively, according to "Agricultural Statistics of Thailand", although the standard of preserving forest land or green area is estimated at 35 percent by the Forest Department of Thailand. From the viewpoint of maintaining the forest for water conservation in the watershed area, adequate measures to increase land productivity without destroying forest are indispensable in the Project Area.

Table 3-3-1. Land Use by Sub-Project (Muban Base)

Item		Lam Plai Mat: Direct Diversion from Dam	Lam Plai Mat: Pakham Diversion Weir	Lam Plai Mat: Total	Nong Lum Puk	Huai Phlu
1. Total of Holding Area		(ha)				
(1) Paddy Field[1]	1977	1,886	6,637	8,523	565	267
	1982	3,386	8,614	12,000	690	996
	Ratio[8]	1.8	1.3	1.4	1.2	3.7
(2) Upland Field[2]	1977	2,323	4,334	6,657	1,092	658
	1982	7,218	5,702	12,920	1,714	2,685
	Ratio[8]	3.1	1.3	1.9	1.6	4.1
(3) Others	1977	710	1,047	1,757	196	16
	1982	749	2,671	3,420	69	127
	Ratio[8]	1.1	2.6	2.0	0.4	7.9
(4) Total	1977	4,919	12,018	16,937	1,853	941
	1982	11,353	16,987	28,340	2,473	3,808
	Ratio[8]	2.3	1.4	1.7	1.3	4.1
2. No. of Farm Households		(farms)				
- Total[3]	1977	1,560	3,240	4,800	500	444
	1982	2,536	4,748	7,284	755	901
- "Rice Main"[4]	1977	168	1,594	1,762	159	49
	1982	276	2,336	2,612	240	100
- "Rice Main" and "Rice + Upland Crops"[5]	1977	759	2,725	3,484	324	207
	1982	1,251	3,993	5,255	488	420
3. Farm Size		(ha/farm)				
- Paddy field[6]	1977	2.49	2.43	2.19	1.74	1.29
	1982	2.71	2.16	2.28	1.41	2.37
- Upland field[7]	1977	1.67	2.63	2.21	3.20	1.67
	1982	3.16	2.36	2.76	3.32	3.35

Note: [6] = [1] ÷ [5], [7] = [2] ÷ ([3] - [4])

[8] ... Increasing rate between 1977 and 1982

Source: 1977 ... 1978 Agricultural Census, the data are for 1977.
1982 ... Dept. of Agricultural Extension, 1982.

The paddy fields of 9,680 ha, 319 ha and 742 ha have been identified as the proposed irrigation supply area, respectively in the Lam Plai Mat, Nong Lum Puk and Huai Phlu. Except for the above areas, the paddy fields outside the proposed irrigation supply area are planned to be supplied with water only for nurseries. These areas cover 2,020 ha, 120 ha and 48 ha respectively in the three sub-project areas:

Paddy Fields Presently Identified in the Project Area

Item	Lam Plai Mat			Nong Lum Puk	Huai Phlu
	Direct Diversion from Dam	Pa Kham Diversion Weir	Total		
1. Inside the proposed Irrigation Area	2,074	7,606	9,680	319	742
2. Proposed Nursery Irrigation Area (Outside the Proposed Irrigation Area)	1,010	1,010	2,020	120	48
Total	3,084	7,707	11,700	439	790

The procedure to identify the above area and the relation between these areas and the previously said land use data are as follows:

(i) The present land use maps of the Lam Plai Mat and the Huai Seo sub-basin have been prepared on the scale of 1:20,000 through the soil survey by RID Study Team and the supplemental survey of the Study Team on present land use (see ANNEX C).

(ii) The proposed canal alignment has been worked out according to the above maps on the condition that all the existing paddy fields are included in the proposed irrigation water supply plan so far as water can be distributed along the topography.

(iii) The paddy field area, for which irrigation water is supplied only for the nursery, has been estimated from village-wise statistical data on the present land use in each Sub-Project area. It is estimated from the whole paddy field minus the estimated irrigation area of (ii)

Land registration in the Project Area is completed only in very limited areas. Particularly, in the upper stream of Lam Plai Mat Sub-Project, NOR SOR3 is covered by less than two percent of the total area. Even in the lower stream where muban have an old history, the registered area is quite limited. Therefore, prior to implementation of the Project, it is requested that "NOR SOR3" be issued to holders, especially for the development of on-farm irrigation systems and as loan collateral for institutional farm credit (see ANNEX D).

(2) Land Tenure

The number of owner farmers in the three Sub-Project areas accounts for 90 to 95 percent of the total, being higher than the national average of 85 percent but approximately equal to 94 percent in the Northeast Region. It appears that the tenant farmers are not in a position to get enough irrigation benefits because their farming conditions are generally unstable due to the high rents, insecure tenant rights, difficulty in securing credit service, etc. However, in view of the relatively small proportion of the tenant farmers in the Project Area, it would not seem to hamper successful implementation of the Project including irrigation, on-farm development and subsequent introduction of new agricultural techniques.

Number of Farms by Land Tenure in the Project Area

(Unit: Farms, %)

Sub-Projects	Owner Farms	Partial Tenant Farms	Tenant Farms	Landless Farms	Total
1. Lam Plai Mat	6,890 (90.3)	297 (3.9)	374 (4.9)	69 (0.9)	7,630 (100.0)
2. Nong Lum Puk	655 (94.9)	14 (2.0)	19 (2.8)	2 (0.3)	690 (100.0)
3. Huai Phlu	738 (91.3)	7 (0.8)	59 (7.3)	4 (0.6)	810 (100.0)
Whole Kingdom	(85.1)	(7.0)	(6.7)	(1.2)	(100.0)
Northeast Region	(94,4)	(2.9)	(1.9)	(0.8)	(100.0)

Note: Number of farms is based on the Project muban level data, 1978 Agricultural Census, NSO.

3.3.2. Farm Households and Population

The population and the number of households in the Project Area have been estimated from available data by muban in 1983 and Agricultural Census 1978, by using aerophotos, topographical maps and administrative district charts.

The total population and the number of households in 1983 of the Project Areas were estimated at 49,400 and 8,700 in Lam Plai Mat Sub-Project, 4,260 and 770 in Nong Lum Puk Sub-Project and 5,390 and 960 in Huai Phlu Sub-Project. As for the number of family members, families with five or six members are predominant.

The number of farm households in Lam Plai Mat, Nong Lum Puk and Huai Phlu Sub-Projects is 7,630 (87.7% of total households), 690 (89.6%) and 810 (84.4%), respectively. The rates of farm households in the three sub-project areas are higher than that of the whole Kingdom (51.8%) and Northeast Region (63.6%). From the result of the farm survey in the Project Area, average farming members per farm is around six, and working family members for farming is three to four in each sub-project.

3.3.3. Agricultural Production

(1) Crops and Cropping Pattern

The present cropping pattern in the Project Area is shown in Figure 3-3-1.

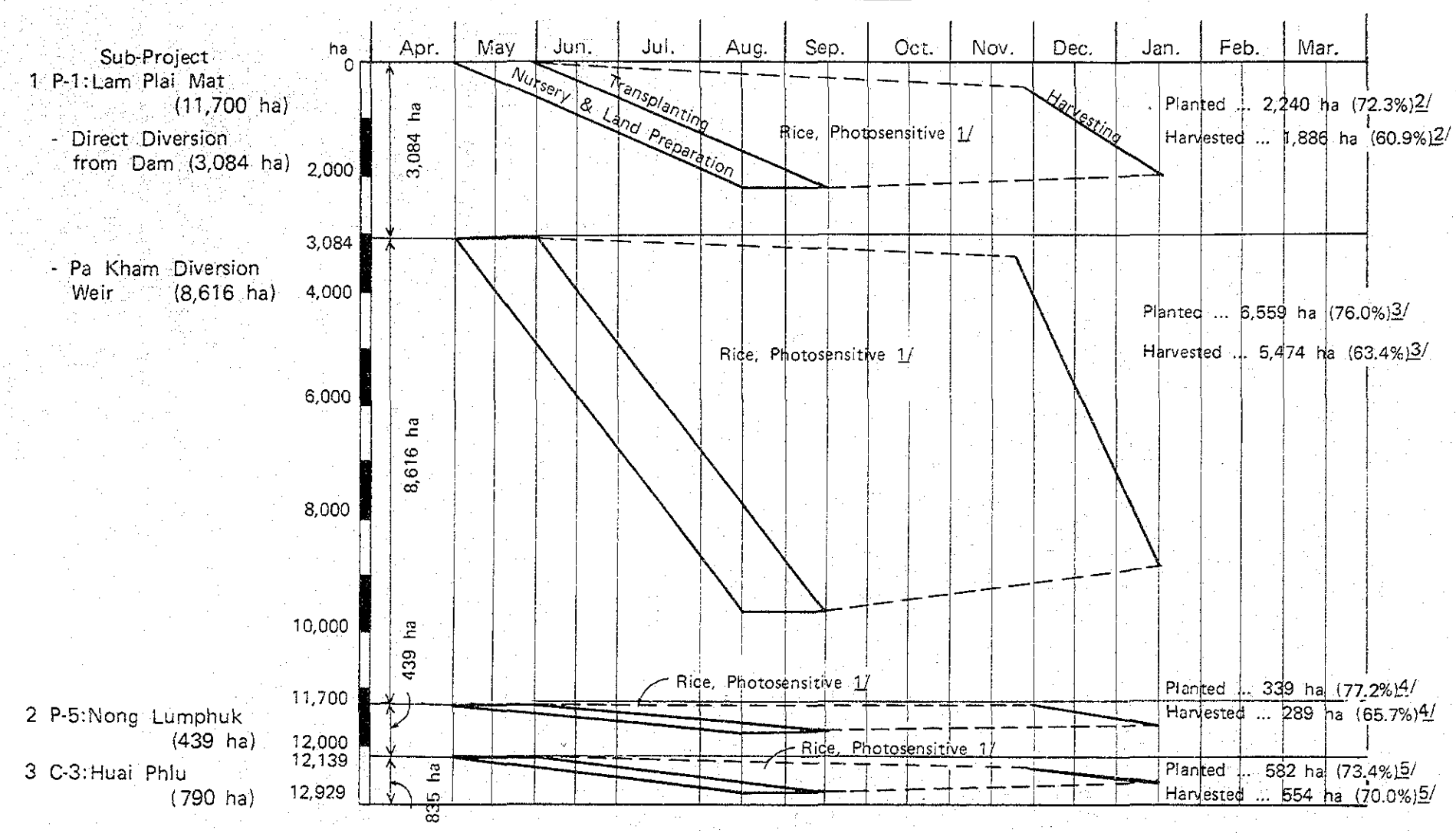
The single cropping of the wet season rice prevails not only in rainfed paddy fields but also in the irrigable area which includes the area commanded by the existing "FAI" (weir system).

Non-glutinous rice varieties cover more than 80 percent of the total area planted with rice in the Project Area in 1978, although glutinous varieties are commonly produced in the Northeast. Both the non-glutinous and glutinous are mostly the photo sensitive type. 25 to 45 percent of the above areas are with the varieties recommended by the Department of Agricultural Extension.

The transplanting time varies year by year depending on the rainfall pattern, while harvesting of these varieties are fixed definitely in every year. The replanting and late planting until October, due to drought, are often observed in case of dry periods after transplanting or continuous drought, which occurred in seven years during the past 13 years from 1970/71 to 1982/83 based on the rainfall observed at Nang Rong Station. In these seven years, there are three years which satisfy the following two conditions; namely, (1) the total rainfall in June and July is less than 40 mm and (2) the total amount of rainfall exceeds 600 mm during August to October. It is considered that there is possibility to expand the planting area by supplying sufficient seedlings in time in these years.

Referring to data in the Farm Economic Survey for 1980/81 to 1982/83 with revision on the basis of concerned data for the past ten years in Buriram changwat, the average planted area and harvested area of the wet season rice are estimated at about 75 percent and 65 percent due to lack of water (see ANNEX D).

Figure 3-3-1 Present Cropping Pattern



Note: * The area replanted due to drought or flood is counted only once.

The analysis of the correlation between the planting area of the wet season rice and related rainfall gives less correlation for rainfalls from May to July, May to August and June to August. Considering the rapid change in land use and incomplete registration of cultivated land, statistical data may not have sufficient accuracy with respect to the percent of planted area and harvested area to the holding area of paddy fields (see ANNEX D).

The area of dry season cropping is negligibly small with an estimated coverage area of the total paddy fields at 2.5 percent, zero percent and 2.3 percent, respectively, in the Lam Plai Mat, Nong Lum Puk and Huai Phlu Sub-Project area. The major dry season crops are groundnut, sesame and mungbean; however, some vegetables are included; these would be planted and irrigated with pond water near villages, mostly for home consumption and local market.

(2) Farming Practices and Inputs

(a) Farming Practices

The wet season rice is mostly transplanted in non-straight rows, usually with the seedlings bred in the wet seedbeds which are not prepared in the strip seedbed. The land preparation comprises the following plowing once or twice by draft animals (almost all buffaloes), with one or two passings per time and one to three times of harrowing by draft animals (almost all buffaloes). The weeding is done manually by only 60 percent of farmers interviewed. Harvesting of rice starts mostly in December in the Project Area, depending upon the varieties selected. The main reason why such late maturing photosensitive varieties have been planted is to minimize both damages by drought and flood. Namely, such varieties could be harvested dispite being transplated too late or too early. Also both the plant height and the vigorous vegetative growth help easily avoid flood damages. Rice is harvested by sickle cutting the top at about one arm's length. The remaining stubbles are fed to

buffaloes and cattle. The threshing is done by applying traditional ways of hitting a bundle held by bamboo sticks and winnowing is also manual. The threshed paddy is stored in individual wooden granaries, and sometimes in Rice Bank granaries among members of the Rice Bank established for famine relief. Usually, paddy is stored for more than one year and older paddy is preferably consumed because older paddy is tastier and paddy is also stored for famine relief. Rice milling is made by rice mill owners in the villages and by rice mill owners in large local urban centers like amphoe Nang Rong.

(b) Farming Inputs

According to the 1983 Farm Economic Survey in the Project Area, the wet season rice production required following farming inputs including labor, draft animal and machinery:

Farming Inputs for Rice Production

Item	Unit	Per Hectare	Total Amount
1. Labor, Draft Animals and Machinery			
- Labor	man-day	82.4	801,000
- Draft Animal	day	16.3	158,000
- Machinery	day	3.0	29,000
2. Seeds	kg	37.5	364,000
3. Fertilizers			
- 16-20-0	kg	15.4	150,000
- 20-20-0	kg	0.1	7,000
- Manure	kg	0.1	7,000
4. Pesticides	฿	1.5	15,000

Source: Farm Economic Survey conducted by Study Team in 1983, for further details, see ANNEX D.

The supply of quality seeds of recommended varieties is taken charge of the by Department of Agricultural Extension. However, during the survey many farmers complained about the insufficient supply of quality seeds. Chemical fertilizer, manure and pesticides are applied by 55 percent, 11 percent and 14 percent of sample farmers in the Farmers' Intention Survey conducted by the Study Team; but the applied amount of these materials is very limited. The reason why extensive cultivation with very limited amount of farm inputs is prevalent in the Project Area is the poor rice cultivation under rainfed conditions.

(3) Crop Production

There are two data sources on the yield of rice, namely, result of the Farm Economic Survey conducted the Study Team for 1980/81 to 1982/83 and statistical data at changwat level for 1972/73 to 1981/82 ("Agricultural Statistics of Thailand", Dept. of Agricultural Economy, MOAC). Considering the following three items, namely (1) the prevailing soil conditions of the suitability for growing rice in the paddy fields of the whole changwat of Buriram and that of the Project Area, (2) the duration of survey period, (3) the sampling method applied in statistical data versus the interviewing method applied in the Farm Economic Survey, the yield of rice in the Project Area is estimated at about 1.3 ton per ha on the basis of statistical data in the Buriram changwat for 1972/73 to 1982/83 as shown below. Yield data of the Farm Economic Survey were used to estimate the yield rating by land class for the assessment of yield in each Sub-Project (see ANNEX D).

The total production of wet season rice is estimated at about 10,900 tons as follows:

Production of Wet Season Rice at Present

Sub-Project	Total Area (ha)	(%)	Planted Area (ha)	(%)	Harvested Area (ha)	(%)	Unit Yield (ton/ha)	Production (ton)
1. Lam Plai Mat	11,700	(100)	8,799	(75.2)	7,360	(62.9)	1.33	9,788
2. Nong Lum Puk	439	(100)	339	(77.2)	289	(62.3)	1.42	411
3. Huai Phlu	790	(100)	580	(73.4)	553	(70.0)	1.21	669
Total	12,929	(100)	9,718	(75.2)	8,202	(63.4)	1.32	10,868

The productivity of the wet season rice in the Project Area is as low as about 50 percent of the national average as seen below, referring to the Productivity Index which is defined in the Preliminary Report by the percentage of harvested areas (holding area of paddy field = 100) multiplied with the yield per hectare.

Productivity Index of Rice in the Project Area

Area	Planted Area (%)	Harvested Area (%)	Unit Yield (ton/ha)	Index
1. Whole Kingdom 1/	80	77	2.34	180
2. Northeast 2/	76	65	1.40	91
3. Sub-Project				
- Lam Plai Mat	75	62	1.33	82
- Nong Lum Puk	77	66	1.42	94
- Huai Phlu	73	70	1.21	85

Note: 1/ Excluding the Northeast Region, average of 1975/76 to 1981/82.
2/ Average of 1979/80 to 1981/82

Source: 1/, 2/ Agricultural Statistics of Thailand Dept. of Agricultural Economics, MOAC.

This low productivity would be attributed to the quite low self-sufficiency of rice in each Sub-Project as described later. It is revealed that rice productivity in terms of the "Productivity Index" is directly related essentially to the distribution of poverty in the Preliminary Study area.

(4) Demand and Supply Balance of Rice

The self-sufficiency of rice in each Sub-Project area is estimated at about 67 percent, 35 percent and 52 percent, respectively for Lam Plai Mat, Nong Lum Puk and Huai Phlu. All of these sub-project areas are exposed to the severest conditions in the Preliminary Study area. This would be attributable largely to poor condition of rice cultivation, difficulty in expanding paddy fields due to topography and soil moisture.

Rice Demand and Supply Balance

Sub-Project	Supply (Production) 1/ (ton)	Demand			Balance (Supply =100) (%)
		Consumption 2/ (ton)	Seeds 3/ and Loss (ton)	Total (ton)	
1. Lam Plai Mat	6,460	8,396	1,292	9,688	67
2. Nong Lum Puk	270	725	54	779	35
3. Huai Phlu	442	763	88	851	52
Total	7,172	9,884	1,434	11,318	63

Note: 1/ Milled rice (Conversion rate from paddy to rice = 66%)
2/ 170 kg/capita/year (Based on Farm Survey, 1983)
3/ 20% of supply.

3.3.4. Animal Husbandry

The animals bred in the Project Area comprise buffaloe, cattle, swine, chickens and ducks. The average number of livestock and poultry per farm household in 1982 for each Sub-Project area is shown below:

Average Number of Livestock and Poultry per Household (1982)

Kind	Lam Plai Mat			Nong Lum Puk	Huai Phlu
	Direct Diversion from Dam	Pa Kham Diversion from Dam	Total		
1. Cattle	(0.12) 0.42	(0.16) 0.59	(0.15) 0.53	(0.07) 0.26	(0.09) 0.33
2. Buffaloe	(1.10) 1.59	(1.87) 2.68	(1.62) 2.32	(0.55) 0.79	(1.75) 2.51
3. Swine	0.68	0.56	0.60	0.54	0.85
4. Chicken	20.88	9.89	13.52	12.06	19.60
5. Duck	2.19	1.89	1.99	1.33	6.54

Note: The figures in parentheses show the estimated number of draft buffaloes and cattle estimated from the ratio of the data in 1978 Agricultural Census for changwat Buriram.

Source: Dept. of Agricultural Extension, 1982. (See ANNEX D)

On an average about 2.8 heads of buffaloes/cattle per farm household are raised in the Lam Plai Mat and Huai Phlu Sub-Project, and the number of draft animals is estimated at 1.8 out of 2.8 heads per farm household. The average number of cattle and buffaloes in the Nong Lum Puk is small, where relatively a large number of tractors or power tillers are used (see ANNEX D). The cattle and buffaloes are fed by rough grazing on rice stubbles, wild grasses along roads or forest edges, etc. If the total amount of rice straw produced at present is converted into Total Digestible Nutrient (TDN), it covers only about 32 percent of the TDN requirement for cattle and buffaloes in all of the three sub-projects (see ANNEX D).

3.3.5. Fishery

According to data prepared by the Department of Agricultural Extension for the year of 1982, there are about 7.6 hectares of fish-culture ponds in the three sub-projects, where such fish as Pranil (Tilapias Nilotica), Carp (Cryprinus Carpio) are commonly raised on a commercial basis. The development of fish culture has been limited in terms of the scale and location because fresh water is available only in a limited period. (See ANNEX D)

A large amount of fresh water fish are caught in various places like streams, ditches and even in the paddy fields during wet season. Including the limited amount of cultured fish, most fish are consumed locally as the main protein source in the Project Area. But, naturally the supply of fish is almost limited to the wet season period.

The production of cultured fish in 1981 is only about 253 ton and 93 ton, respectively, in changwat Nakhon Ratchasima and Buriram according to the Department of Fisheries. This amount means per capita consumption of only 0.2 kg and 0.1 kg. The average annual consumption of freshwater fish, including the converted amount of the dried and processed fish in raw weight, is estimated at about 22 kg in the Study Team's Farm Economic Survey, 1983.

Considering the said unstable supply of freshwater fish, it is required to develop fish culture in the Project.

3.3.6. Agricultural Supporting Service

(1) Research

There is no agricultural station responsible for irrigated agriculture around the Project Area. As for rainfed agriculture, there is the Surin Rice Experiment Station in neighboring Surin changwat, about 90 km northeast of Pa Kham. The main objective of

the station is to find rice varieties suited for the area and the breeding of new varieties and also production/distribution of breeder's seed and foundation seed for seed multiplication. There are 10 staff members serving about 46 hectares of paddy fields provided and irrigated by Huai Saneng Irrigation Project. The soils of the station fields are classified into the third class according to the land classification of the Department of Land Development. The same kind of soils also prevail in the Project Area and the climatic condition between the Project Area and the station is almost the same. In another changwat of Nakhon Ratchasima, there is the Pimai Rice Experiment Station where the yield level of rice is higher than that of the Surin Rice Experiment Station due to favourable soil conditions.

Other research stations like the "Crop Experimental Station" and the "Maize and Sorghum Research Station" are located in changwat Nakhon Ratchasima for research in upland crops under rainfed conditions.

The FAO/UNDP Irrigated Agriculture Development Project located at Kalasin aims at research in irrigated agriculture in the Northeast. Data provided by the Project serves for project formulation of the irrigation Project.

(2) Extension

The National Agricultural Extension Project (NAEP) is implemented in two phases under the financial and technical assistance of the World Bank. The two changwat of Buriram and Nakhon Ratchasima, have been covered in Phase one from 1977 to 1980, and the number of agricultural extension staff has been increased with other strengthening measures down to the amphoe office level.

Number of Agricultural Extension Staff (as of 1983)

Amphoe/King Amphoe	No. of Staff1/	No. of Farmers and Area per Staff	
		No. of Farmer	Area
1) Soeng Sang	4	1:1,500	1:6,400 ha
2) Pa Kham	3	1: 900	1:6,400
3) Nang Rong	16	1:1,300	1:4,800
4) Ban Kruat	8	1:1,200	1:3,900

Note: 1/ Includes the Amphoe Agriculture Officer and the Assistant of Agriculture Officer.

These agricultural extension staff members will visit "contact farmers" regularly, sometimes ordinary farmers directly, and have regular training and meetings with the staff of agriculture related organizations such as the Plant Protection Team, RID, Land Development Department, Animal Husbandry Department, etc. for exchanging knowledge and improving communication.

The extension staff in the Project Area is generally not accustomed to practising irrigated agriculture because their activities are oriented to rainfed agriculture. Moreover, there were many sample farmers who complained of the inadequate extension services rendered by the Dept. of Agricultural Extension at present.

(3) Agricultural Cooperative and Crediting

In the Project Area, there are 28 agricultural cooperatives having a total membership of 424 or about five percent of the total farm households. (See ANNEX D)

The cooperatives handle the input materials such as fertilizers, chemicals and animals feeds for sale, and paddy and peanut for procurement and also render crediting services under financial supports from BAAC. The procurement is done under the governmental price supporting scheme.

The agricultural cooperative is the foundation for encouraging local agricultural development, and therefore, should be strengthened to meet the requirements of the farmers concerned. The problems faced by cooperatives are as follows:

(a) The merchants intervene in every transaction of forwarding and marketing of all farm products resulting in reduction of the farmer's net income.

(b) Only about five percent of the total farmers have been members of the agricultural cooperatives, and the cooperatives have been functioning incompletely as the service organization for the farmers.

(c) The cooperatives lack staffing and their working capacity is still inadequate to cope with the situation.

The private sector of middlemen and merchants, etc. appears to strongly influence the farmers' decision making in terms of both credit and marketing. Most of the farmers in the Project Area are characterized by having low and/or unstable income and by debt; and there are many farmers who borrow money in advance and have to sell their products to the money lenders at a quite low price level.

(4) Farmers' Organization

The following farmers' groups are organized under the guidance of the respective government agencies:

(a) Farmers' Association under guidance of the Department of Agricultural Extension (DOAE).

(b) Home Economic Group under the guidance of DOAE.

(c) Youth Farmers' Group under guidance of DOAE.

(d) BAAC Group under the guidance of BAAC.

(e) Women's Group under the guidance of Community Development Department (CDD).

(f) Youth Group under the guidance of CDD.

(g) Agricultural Cooperative under the guidance of Cooperative Promotion Department.

(h) Water Users' Association

Out of the above eight groups, two pairs of "Home Economics Group" and "Women's Group", "Youth Farmers' Group" and "Youth Group" are respectively going to be integrated under the coordination among agencies concerned because every farmer member has been registered in the same groups among the pair group.

The members of each group are quite limited like the members of Agricultural Cooperative. (See ANNEX D)

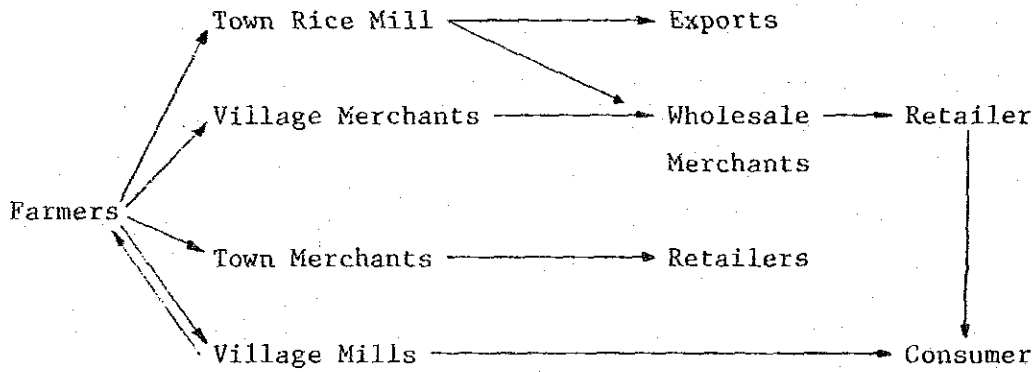
3.3.7. Marketing Structure

The major farm products in the Project Area are rice, cassava and maize. The Project Area is not self-sufficient in rice, however, a very small amount of the products has been exported outside. In changwat Buriram and Nakhon Ratchasima, some high quality rice has been exported to other areas, mainly Bangkok through the hands of rice millers or merchants.

The major crops, other than rice, play an important role in farm economy, especially cassava and maize for the international market and some vegetables for the local market, and trading of those crops is made by merchants with high commercial values.

In connection with the construction of the Nang Rong Dam, the Royal Food Factory, which has been in operation under the King's Project since 1982 for the processing of various tomato products and canning of baby corn and young bamboo shoots and for drying of chili and onion, for the increasing of income in the border areas. Some farmers are selected for receiving assistance in supply of farm inputs and other extension services, directly by the factory and also respective staff of the Department of Agricultural Extension.

The marketing channels of rice are shown below:



3.3.8. Farm Economy

As aforesaid, 7,630; 690 and 810 farm households are cultivating lands in Lam Plai Mat, Nong Lum Puk and Huai Phlu Sub-Project, respectively. Generally, farm households are divided into three farming types as shown below, i.e., cultivating only wet season paddy, wet season paddy and upland crops, and only upland crops. Three sub-projects are located in the hilly upper stream of Lam Plai Mat and Lam Chi Noi basins. And in each sub-project area, the proportion of farms cultivating upland crops, mainly cassava, is very large compared with that in the lower stream.

Number of Farm by Type of Farming

(Unit: farm, %)

Sub-Project	Rice Main Production	Rice + Upland Crop	Upland Crops & Others	Total
1. Lam Plai Mat	2,765 (36.2)	2,716 (35.6)	2,149 (28.2)	7,630 (100)
2. Nong Lum Puk	64 (9.3)	407 (59.0)	219 (31.6)	690 (100)
3. Huai Phlu	90 (11.1)	287 (35.5)	433 (53.4)	810 (100)

Source: 1978 Agricultural Census, NSO.

The average total operated area per farm in Lam Plai Mat, Nong Lum Puk and Huai Phlu Sub-Projects is 3.7 ha, 3.3 ha and 4.2 ha, respectively. The main crops are paddy, cassava, and maize in descending order.

As a result of the farm survey, the average agricultural income including income in kind, in Lam Plai Mat, Nong Lum Puk and Huai Phlu are calculated at 15,420, 34,400 and 18,380, respectively. In any Sub-Project, more than 80 percent of the agricultural income is shared by paddy and cassava. The average farm income in Lam Plai Mat, Nong Lum Puk, Huai Phlu Sub-Project is 21,490, 50,760 and 28,060. And agricultural income in each sub-project accounts for more than 65 percent (see Table 3-3-2).

Table 3-3-2 Average Agricultural Income of Smaple Farm

(unit: ฿/farm)

Sub-projects	1. Lam Plai Mat	2. Nong Lum Puk	3. Huai Phlu
1. No. of Samples	89	62	50
2. Agricultural Income*1			
2-1 Crops			
- Paddy	11,910 (52.2%)	4,660 (11.2%)	7,890 (30.0%)
- Cassava	7,040 (30.8)	31,800 (76.4)	15,260 (58.0)
- Maize	720 (3.1)	2,390 (5.8)	60 (0.3)
- Others	200 (0.9)	60 (0.1)	1,160 (4.4)
- Sub-total	19,870 (87.0)	38,910 (93.5)	24,370 (92.7)
- Livestock	2,960 (13.0)	2,720 (6.5)	1,930 (7.3)
Total	22,830 (100.0)	41,630 (100.0)	26,300 (100.0)
2-2 Cost Paid	7,410	7,230	7,920
2-3 Agri Income (2-1) - (2-2)	15,420 [71.8]	34,400 [67.8]	18,380 [65.5]
3. Off-Farm Income	6,070 [28.2]	16,360 [32.2]	9,680 [34.5]
4. Farm Income	21,490 [100.0]	50,760 [100.0]	28,060 [100.0]

Note : *1 --- Farm income includes income in kind and cash

Table 3-3-3 Income Level in the Project Area, at Present

Price = 1982/83

Sub-Project	Poor (<3,500)	Marginal (3,500 - 4,670)	Better-off (4,670 - 7,000)	Wealthy (>7,000)	Overall (฿ per capita)
1. Income Distribution of Rural Household in Northeast, 1975/76					
No. of Households (%)	(43.3)	(27.1)	(22.3)	(7.3)	(100.0)
Average Income, 1982/83 (converted from 1975/76) (฿ per Household)	17,450	25,270	37,480	77,620	28,540
2. Income Distribution of the Project Sample Farms, 1982/83					
(1) Lamp Plai Mat Sub-Project (Upper and Midstream)					
No. of Households	56	13	13	7	89
(%)	(62.9)	(14.6)	(14.6)	(7.9)	(100.0)
Ave. Household Income (฿)	13,270	25,910	35,830	52,800	21,490
Ave. Family Size	6.2	6.4	6.1	4.0	6.0
(2) Nong Lumphuk Sub-Project					
No. of Households	19	9	10	24	62
(%)	(30.6)	(14.5)	(16.1)	(38.8)	(100.0)
Ave. Household Income (฿)	14,410	27,050	31,310	95,820	50,760
Ave. Family Size	6.4	6.3	5.8	5.8	6.1
(3) Huai Phlu Sub-Project					
No. of Households	28	5	10	7	50
(%)	(56.0)	(10.0)	(20.0)	(14.0)	(100.0)
Ave. Household Income (฿)	12,572	26,710	39,010	74,480	28,060
Ave. Family Size	6.1	6.4	6.8	6.1	6.3