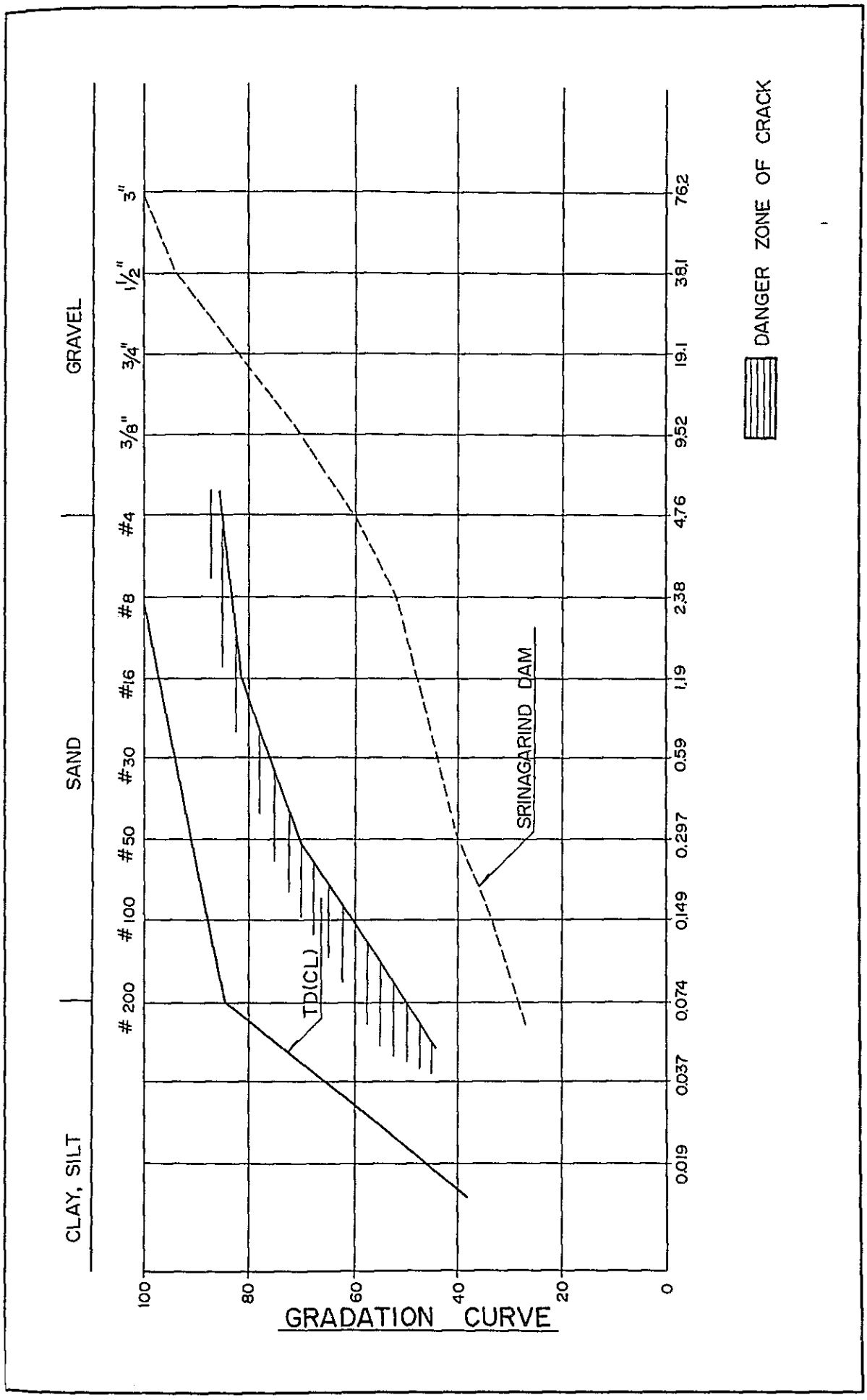
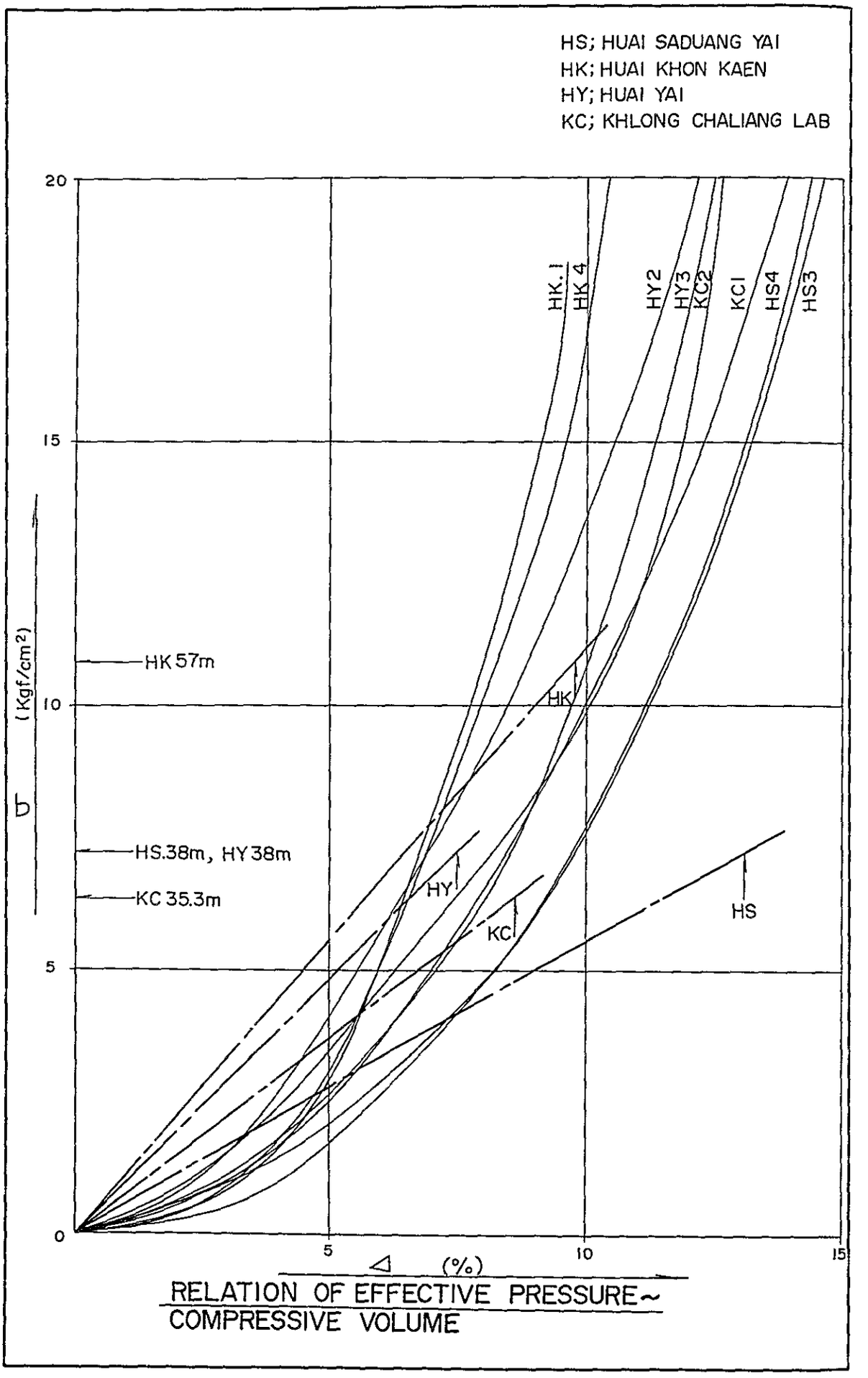
FIG. II-15


GRAVEL
SAND
CLAY, SILT
3"
1½"
¾"
⅜"
#4
#8
#16
#30
#50
#100
#200
76.2
38.1
19.1
9.52
4.76
2.38
1.19
0.59
0.297
0.149
0.074
0.037
0.019
100
80
60
40
20
0
GRADATION CURVE
TD(CL)
SRINAGARIND DAM
DANGER ZONE OF CRACK



RELATION OF EFFECTIVE PRESSURE~ COMPRESSIVE VOLUME

ANNEX III
SOILS AND LAND CLASSIFICATION

ANNEX - III

SOILS AND LAND CLASSIFICATION

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ANNEX - III

SOILS AND LAND CLASSIFICATION

1. GENERAL

The four sub-projects have been identified under the Upper Pasak Medium Scale Irrigation Project: they are Huai Saduang Yai (44,960 rai), Huai Khon Kaen (44,060 rai), Huai Yai (15,040 rai) and Khlong Chaliang Lab (9,240 rai). The proposed net irrigation area is about 84,380 rai (13,500 ha) in total. These sub-projects are scatteringly located in the Upper Pasak area, which extends along the Pasak river in the Phetchabun Province.

The present soil study aims at identifying major soil groups and their distribution in the Upper Pasak area to evaluate the endowed land resources, and also examining the suitability of each soil group identified in the proposed sub-project areas through the review of the past soil studies and supplementary field investigation.

The detailed-reconnaissance soil survey has been carried out for the whole country by the Land Development Department, the Ministry of Agriculture and Cooperatives, and the survey results are presented on the topographic maps scaled 1/100,000. In most cases the basic unit for soil classification is "soil series". The land capability classification has also been made by the Land Development Department, in order to classify the land resources in the country, through interpretive generalization of "soil series" identified in the detailed-reconnaissance soil survey.

The present soil classification study is based on the detailed-reconnaissance soil maps of the Phetchabun Province produced by the Land Development Department. The land capability study is, however, made on the basis of the actual field survey in the sub-project areas, which has been carried out by the Soil and Geology Division of RID.

2. PHYSIOGRAPHY AND SOILS

The Pasak river basin is located in the north-central region of Thailand. The basin shape is long and narrow extending generally from north to south, with an average width of about 50 km and an approximate length of 300 km. The total area of the basin is about 15,700 km². The Upper Pasak area is located in the upper part of the basin, mainly extending on the left bank of the Pasak river. The Upper Pasak area contains about 750 km².

From the physiographic viewpoints, the lands in the Upper Pasak area are classified into five (5) categories (see FIG. III-1):

Land Category	Area (Rai)	Area (Ha)	%
1. flat alluvial plain of recent alluvium	150,500	24,080	32.2
2. low terraces and fans of semi-recent alluvium	71,120	11,380	15.2
3. low terraces of old alluvium	5,380	860	1.1
4. high terraces of old alluvium	210,380	33,660	45.0
5. dissected erosion surfaces and hills	30,120	4,820	6.5
TOTAL	467,500	74,800	100.0

The major soils covering the Upper Pasak area are those on (1) flat alluvial plain and (2) low alluvial terraces and fans. These occupy about 47 % of the total area. The soils developed on (4) high terraces and (5) dissected erosion surfaces and hills are not irrigable due to their steep topography. Even if the lands are partly irrigable, these are not suited to irrigation farming due to their general features of sandy and/or gravelly shallow soil depth and low inherent fertility. The soils on (3) old low terraces are marginal for irrigation, however, the area of these soils is relatively small and scattered.

A total of ten "soil series" are identified on the major land categories: (1) flat alluvial plain and (2) semi-recent low terraces and fans. The major soil characteristics of these ten soil series; together with the soil series developed on other land categories, are summarized in TABLE III-1. Out of the soil series, 15 soil series are identified in the four sub-project areas, as shown in FIG. III-2 (SOIL MAP). In view of the extension and distribution, it is considered that the following seven (7) soil series are significant for agriculture use.

1. Lom Sak series
2. Chaliang Lab series
3. Tha Phon series
4. Ban Pod series
5. Hang Dong series
6. Nakhon Pathom series
7. Dong Yang En series.

Detailed standard soil profile descriptions of all the soil series in Thailand are available in the Land Development Department. These descriptions are, however, not specific to the Upper Pasak area but apply generally wherever the soils occur in Thailand. The generalized brief notes on the above seven (7) soil series are given below:

Lom Sak Series (La)

These soils are formed from recent riverine alluvium and occur on the lower part of the flat alluvial plains. They are characterized by very deep effective soil depth, clayey texture and relatively high inherent fertility. Soil reaction is medium acid to neutral. Drainage is generally poor either vertically and horizontally, but the soils dry up in the dry season. The lower part of the area that these soils extend is annually subject to flash flooding generally in September. The Lom Sak series occupy about 60,820 rai or 53.7 % of the total area. They are classified as Hydromorphic Alluvial Soils (National), or Aeric Tropaquepts (USDA) or Eutric Gleysols (FAO/UNESCO).

Chaliang Lab Series (Cl)

These soils are very similar to Lom Sak series in profile development, but less fertile and more poorly drained than Lom Sak series. They particularly occur on lower part of the recent alluvial plain developed along the Khlong Chaliang Lab. These soils occupy about 2,550 rai or 2.3 % of the total area. They are classified as Hydromorphic Alluvial Soils (National), or Typic Tropaquepts (USDA) or Dystic Gleysols (FAO/UNESCO).

Tha Phon Series (Tn)

Tha Phon soils are formed from recent alluvium and occur mainly along the right bank of the upper reaches of the Pasak river. Relief is flat to almost flat with slopes of less than 2 %. The soils are somewhat poorly drained. Groundwater level falls below 3 m during the dry season. These soils are generally deep, slightly acid to neutral in soil reaction and medium to fine textured and are characterized by distinct brown mottlings throughout the profile. The Tha Phon soils exclusively occur in the Huai Saduang Yai sub-project area and occupy about 5,330 rai in total, which correspond to 4.7 % of the total gross project area. This soil series is one of the Hydromorphic Alluvial Soils (National) and is classified as Aeric Tropaquepts (USDA) or Eutric Gleysols (FAO/UNESCO).

Ban Pod Series (Bpo)

Ban Pod Series are formed from recent riverine alluvium of calcureous materials. These soils occur extensively along the middle and lower reaches of the Pasak river. They are very deep, very fine clayey, medium acid to neutral, and dark coloured soils. Relief is flat with slope less than 1 %. Drainage is generally poor. These soils occupy about 5,370 rai or of the total area. They are classified as Hydromorphic Alluvial Soils (National), or Vertic Tropaquepts (USDA) or Eutric Gleysols (FAO/UNESCO).

Hang Dong Series (Hd)

These soils are developed on semi-recent alluvium and occur on low terraces. Relief is flat to nearly flat with a micro-relief caused by the presence of scattered termite mounds. The soils are medium to fine textured and generally poorly drained. The soils profile is well developed with argillic B horizon. The soils is generally deep and soil reaction is medium acid to neutral, pH value increasing with depth. These soils occupy about 590 rai or 0.5 % of the total gross area. They are classified as Low Humic Gley Soils (National), to Typic Tropaquets (USDA) or Eutric Gleysols (FAO/UNESCO).

Nakhon Pathom Series (Np)

Nakhon Pathom soils are formed from semi-recent riverine alluvium and found on low terraces. Relief is flat to nearly flat with abundant micro-relief by termite mounds. They are deep, slightly acid to medium acid surface over neutral to moderately alkaline subsoils, and generally medium to fine textured. Drainage is generally poor, but soils deeply dry up in the dry season. These soils occupy about 23,190 rai in total or 20.5 % of the total gross project area. They are classified as Hydromorphic Non-Calcic Brown Soils (National), or Aeric Tropaqualts (USDA) or Gleyic Luvisols (FAOJUNESCO).

Dong Yang En Series (Don)

These soils are derived from semi-recent alluvium on the coalescing alluvial fans. They are generally deep, moderately well drained, medium to fine textured, medium acid in the surface and medium to strong acid in the subsoils, and generally brown coloured. Relief is flat to gently undulating with slope range of 1-3 %. These soils are generally used for upland cropping. These occupy about 2,820 rai or 2.5 % of the total gross area. These soils are classified as Non-Calcic Brown Soils (National), or Ultic Haplustalfs (USDA) or Orthic Luvisols (FAO/UNESCO).

The distribution of each soil series in each sub-project area is summarized in TABLE III-2. The results of the laboratory analyses of the representative soil samples taken from each soil series are shown in TABLE III-3.

3. LAND CLASSIFICATION STUDY

3.1 Field Procedure and Mapping

Land classification survey of four sub-project areas was carried out by the Soil and Geology Division of RID. Soil profile survey including test pits and auger observations was made at the representative points selected through interpretation of aerial photos scaled 1/15,000, and the soil was described by horizons and the representative soil samples were taken for laboratory analysis. Location of sample points and observation points were marked on transparent overlays of 1/15,000 scale aerial photos, and land classification boundaries were drawn directly onto these overlays using the field data and information. At the same time details of present land-use at each observation point were plotted onto a second, transparent overlay.

The field mapping on these 1/15,000 scale aerial photos were then reduced directly onto 1/50,000 topographic maps. Field checking and compilation of these field maps was carried out by JICA Team.

3.2 Land Classification System

The land classification system employed is that introduced in the Greater Mae Khlong Multi-purpose Project in 1968, and since used in many project studies by RID. The system is formulated through the observations and studies on soil, drainage and topographic characteristics of the project lands and their effects on crop productivity under irrigation. The standard specification for land classification is shown in TABLE III-4. The framework of the system is basically three (3) classes rating for rice and upland crops. Limitations on suitability of land due to soil, drainage and topography are indicated by the use of symbols "s", "d" and "t" either individually and collectively, and in places where a constraint due to flash flooding is recognized an additional symbol "f" is used. The definitions of these land class groups are as follows:

Land Class Group	Definition
U1	Land best suited for upland irrigation crops.
U2	Land less suitable for upland irrigated crops with one or two limitations in the soil, topography or drainage.
U3	Land of distinctly restricted suitability for upland irrigated crops because of extreme limitations in the soil, topography or drainage characteristics.

Land Class Group	Definition
R1	Land best suited for irrigated rice production.
R2	Land adapted for rice production but with one or more limitations.
R3	Not included in original classification but used throughout the medium scale irrigation studies to indicate land usable for rice production but with severe limitations often necessitating special methods of cultivation, or cultivation only when general conditions permit.
U2/R2	Land suitable for either upland crops or rice particularly, but with one or more limitations for both upland crops and rice.
6	Non-arable land. Land unsuitable for the production of crops.

With three (3) arable land classes for rice and upland crops and with each land class having four or more sub-classes, a great number of combinations of land class symbols is possible if much variation occurs in the soil, drainage, topography or additional flood conditions of a project land. Actually, however, only nine (9) different composite land class symbols were used in the classification of the arable lands in the sub-project areas. The following shows the major groups identified in the four sub-project areas and land class symbols each group represents:

Land Class Group	Land Class
R1	U2sd/R1
R2	U3sdf/R2f
R3	U2st/R3st, U2t/R3st
U2/R2	U2s/R2s, U2sd/R2s, U2st/R2t, U2st/R2st
U1	not applicable
U2	not applicable
U3	U3st/R6st

3.3 Results of Land Classification

The total area of the Upper Pasak Medium Scale Irrigation Project is 113,300 rai. The distribution feature of each land class group in the sub-project areas is summarized as follows (for details, vide TABLE III-5):

Land Class Group	Sri Chan Area	Pasak Left Bank Area	Huai Khon Kaen Area	Huai Yai Area	Khlong Chaliang Lab Area	Total
R1	3,500	22,930	13,850	7,250	5,370	52,900
R2	4,030	10,700	-	-	-	14,730
R3	460	4,640	7,870	2,650	2,750	18,370
U2/R2	-	1,920	11,670	3,320	840	17,750
U3	-	1,770	4,410	1,500	280	7,960
Others	-	110	1,160	320	-	1,590
Total	7,990	42,070	38,960	15,040	9,240	113,300

From the above summarized data of land classification, 103,750 rai would be suitable for either rice or upland crops. These lands are most suitable for double cropping of rice or rice production in the rainy season and upland irrigated crops in the dry season, depending on the availability of irrigation water. The land-use survey results show that these lands suitable for rice production are nearly all in cultivation and used almost exclusively for rice. Mung beans and tobacco are predominant on these lands as second crops after rice harvest.

The land classification map covering the Upper Pasak Medium Scale Irrigation Project area is given in FIG. III-3. The general features of the major land classes occuring in each sub-project area are shown in TABLE III-6, together with suggested land-use for each land class.

4. INFILTRATION RATE MEASUREMENT

Infiltration rates of water into the soil were measured at the location indicated on the Land Classification Map (FIG. III-3). The double ring infiltrometer method was adopted, and measurements were made both at the ground surface and at the depth of around 20 cm below the surface. All the measurement sites were selected on the existing paddy field and the measurement was made during the dry season (April - May, 1982). Evaporation during the measurement period of time was disregarded. TABLE III-7 shows the partial and cumulative infiltration rates of different soil series at four (4) selected sites, and may give some idea of rates of water entry into the soils which will be expected under irrigation.

MAJOR CHARACTERISTICS OF SOIL SERIES IN THE UPPER PASAK AREA

Land-form and Parent Mayerials	National Soil Series Names & Symbols	Classification[1] 1. National 2. USDA-1975 3. FAO/UNESCO	Range of Slope (%)	Effective[2] Soil Depth	Texture[2] Profile a. Topsoil b. Subsoil	Colour[3] Profile a. Topsoil b. Subsoil	Structure[3] a. Topsoil b. Subsoil	a. Drainage[4] b. Permeability c. Surface Runoff	Organic[5] Matter (0-30cm)	CEC[6] a. 0-30cm b. 30cm	Base Saturation[7] (%) a. 0-30cm b. 30cm	Available Phosporus[8] a. 0-30cm b. 30cm	Exch. Potassium a. 0-30cm b. 30cm	Reaction (pH) a. 0-30cm b. 30cm	Land Capability a. for Paddy b. for Upland Crop	Area (ha)
Flat Alluvial Plain of Recent Riverine Alluvium	1.Tha Muang (Tm)	1 Alluvial soils 2.Typic Ustifluvent 3.Eutric Fluvisols	< 2	very deep	a. sandy loam b. loam	a. brown b. dark yellowish brown	a. moderate fine and medium sub-angular blocky b. moderate fine and medium sub-angular blocky	a. moderately well b. moderate c. medium	moderately low to medium	a. medium b. medium	a. medium to high b. medium to high	a. moderately high b. medium	a. medium b. medium	a. 6.0-7.0 b. 6.0-7.0	a. Vt b. IIf	580
	2.Lom Sak (La)	1.Hydromorphic alluvial soils 2.Aeric Tropaquet 3.Eutric Gleysols	< 1	very deep	a. silty clay b. clay	a. dark brown b. grayish brown	a. moderate medium and coarse sub-angular blocky b. moderate medium and coarse sub-angular blocky	a. somewhat poorly b. slow c. slow	medium	a. high b. high	a. medium b. medium	a. moderately high b. moderately high	a. very high b. medium	a. 6.0-7.0 b. 6.0-8.0	a. IIf b. IIIdf	15,840
	3.Chumsaeng (Cs)	1.Hydromorphic alluvial soils 2.Aeric Tropaquet 3.Futric Gleysols	< 1	very deep	a. clay loam b. silty clay to clay	a. dark grayish brown b. pinkish gray	a. weak to moderate medium and coarse sub-angular blocky b. moderate medium coarse blocky	a. poorly b. slow c. slow	medium	a. high b. high	a. high b. high	a. very high b. very high	a. very high b. very high	a. 6.0-7.0 b. 6.5-7.0	a. IIf b. IIIdf	160
	4.Chaliang Lab (Cl)	1 Hydromorphic alluvial soils 2.Typic Tropaquept 3.Dystic Gleysols	< 1	very deep	a. silty clay b. silty clay to clay	a. grayish brown b. light brownish gray	a. weak to moderate medium sub-angular blocky b. moderate medium sub-angular blocky	a. poorly b. slow c. slow	medium	a. medium b. medium	a. medium b. medium	a. medium b. very low	a. medium b. low	a. 5.0-6.0 b. 4.5-5.5	a. IIf b. IIIdf	850
	5 Tha Phon (Tn)	1.Hydromorphic alluvial soils 2.Aeric Tropaquept 3.Futric Gleysols	< 1	very deep	a. silty clay b. clay	a. dark brown b. dark reddish brown	a weak to moderate medium sub-angular blocky b. moderate medium sub-angular blocky	a. somewhat poorly b moderate to slow c. slow	medium	a. very high	a. high	a. high	a. medium	a. 6.0-7.0	a. IIf	1,070
	6.Ban Pod (Bpo)	1.Hydromorphic alluvial soils 2.Vertic Tropaquept 3.Gleysols Vertic	< 2	very deep	a. silty clay b. clay	a. dark grayish b. dark yellowish brown	a. moderate fine to medium sub-angular blocky b. strong medium sub-angular blocky	a. somewhat poorly b. slow c. slow	medium	a. very high b very high	a. medium b. high	a. low b. very low	a. low b. low	a. 5.5-6.5 b. 6.0-7.0	a. IIf b. IVdf	5,530
	7.Phimai (Pm)	1 Hydromorphic alluvial soils 2.Vertic Tropaquept 1.Gleysols Vertic	< 1	very deep	a. clay b. clay	a. dark gray b. dark gray	a. moderate medium to coarse sub-angular blocky b. moderate medium to coarse blocky	a. poorly b. slow c. slow	medium	a. very high b. very high	a. medium b. high	a. low b. very low	a. very high b. very high	a. 5.5-6.5 b. 6.0-7.0	a. IIm b. IVdf	50

TABLE III-1 (1)

MAJOR CHARACTERISTICS OF SOIL SERIES IN THE UPPER PASAK AREA (Cont'd)

Land-form and Parent Materials	National Soil Series Names & Symbols	Classification[1] 1. National 2. USDA-1975 3. FAO/UNESCO	Range of Slope (%)	Effective[2] Soil Depth	Texture[2] Profile a. Topsoil b. Subsoil	Colour[3] Profile a. Topsoil b. Subsoil	Structure[3] a Topsoil b. Subsoil	a Drainage[4] b. Permeability c. Surface Runoff	Orginic[5] Matter (0-30cm)	CEC[6] a. 0-30cm b. 30cm	Base Saturation[7] (%) a. 0-30cm b 30cm	Available Phosporus[8] a. 0-30cm b. 30cm	Exch[9] Potassium a. 0-30cm b. 30cm	Reaction (pH) a. 0-30cm b. 30cm	Land Capability a. for Paddy b. for Upland Crop	Area (ha)
Low Terraces and Fans of Semi-Recent Riverine Alluvium	8.Hang Dong (Hd)	1.Low Humic Grey soils 2.Tropaqualf 3.Orthic Luvisols Typic	<1	very deep	a. clay loam b. silty clay	a. dark gray b. yellowish brown	a. moderate fine to medium sub-angular blocky b. moderate medium sub-angular blocky	a. poorly b. slow c. slow	medium	a. medium b. moderately high	a. medium b. high	a. medium b. low	a. medium b. medium	a. 5.5-6.5 b. 6.0-7.0	a. IIm a. IIId	150
	9 Nakhon Pathom (Np)	1.Hydromorphic Non Calcic Brown soils 2.Aeric Tropaqualf 3.Gleyic Luvisols	<1	very deep	a. clay loam b. silty clay	a. dark brown b. dark grayish brown	a. moderate fine to medium sub-angular blocky b. moderate to strong medium sub-angular blocky	a. somewhat b. slow c. slow	medium	a. moderately high b. moderately high	a. medium b. high	a. high b. high	a. very high b. high	a. 5.0-5.5 b. 6.0-8.0	a. IIm b. IIId	8,970
	10.Dong Yang En (Don)	1.Non Clacic Brown Soils 2.Ultic Haplustalf 3.Ferric Luvisols	1-3	very deep	a. silty loam b. silty clay loam	a. dark brown b. reddish brown	a. moderate fine to medium sub-angular blocky b. moderate to strong medium sub-angular blocky	a. moderately well b moderate c. medium	medium	a. medium b. medium	a. medium b. medium	a. medium b. moderately high	a. high b medium	a. 6.0-7.0 b. 5.0-6.0	a. Vt b IIm	2,260
SUB-TOTAL																35,460
Low Terraces of Old Riverine Alluvium	11. Na Chaliang (Nc)	1.Hydromorphic Non Calcic Brown soils 2.Aeric Paleaquult 3.Gleyic Luvisols	1-3	very deep	a. sandy clay loam b. gravelly clay loam	a. dark brown b. grayish brown	a. weak fine to medium sub-angular blocky b. weak medium to coarse sub-angular blocky	a. somewhat poorly b. moderate c. medium to slow	medium	a. moderately high b. high	a. medium b medium	a. very low b. very low	a. medium b. low	a 5.5-6.5 b. 6.0-8.0	a. IVsm b. IVds	370
	12.Sakhon (Sk)	1.Groundwater Lateritic Soils 2.Pretoferric Haplustult 3.Plinthic Acrisols	1-2	shallow	a. sandy loam b. gravelly loam	a. very dark grayish brown b. reddish brown	a weak to moderate fine to medium sub-angular blocky b. weak to moderate fine to medium sub-angular blocky	a. somewhat poorly b. slow c. slow	very low	a low b. low	a. low b low	a. very low b very low	a. low b. low	a. 5.5-6.5 b. 4.5-5.5	a. IVsm b. IVs	260
	13. Pak Tho (Pt)	1.Low Humic Grey soils 2.Aeric Paleaquult 3.Plinthic Gleysols	<1	very deep	a clay loam b. clay	a. grayish brown b. light gray	a. weak medium sub-angular blocky b. moderate medium to coarse sub-angular blocky	a. somewhat poorly b. slow c. slow	low	a. low b. medium	a. medium b. low	a. low b. low	a. low b. medium	a. 5.0-5.5 b. 4.5-5.0	a. IIIsm b. IIIds	230
	14. Phetchabun (Pe)	1.Reddish Brown Lateritic soils 2.Paleustult 3.Ferric Acrisols	2-8	very deep	a. sandy loam b sandy clay loam	a. dark brown b. reddish brown	a. moderate fine sub-angular blocky b. moderate medium sub-angular blocky	a. moderately poor b. moderate c. medium	medium	a. medium b. medium	a. medium b. low	a. low b. very low	a. medium b. very low	a. 5.5-6.5 b. 7.5-5.5	a. Vt b. IIIsm	3,020

MAJOR CHARACTERISTICS OF SOIL SERIES IN THE UPPER PASAK AREA (Cont'd)

Land-form and Parent Mayerials	National Soil Series Names & Symbols	Classification[1] 1. National 2. USDA-1975 3. FAO/UNESCO	Range of Slope (%)	Effective[2] Soil Depth	Texture[2] Profile a. Topsoil b. Subsoil	Colour[3] Profile a. Topsoil b. Subsoil	Structure[3] a. Topsoil b. Subsoil	a. Drainage[4] b. Permeability c. Surface Runoff	Organic[5] Matter (0-30cm)	CEC[6] a. 0-30cm b. 30cm	Base Saturation[7] (%) a. 0-30cm b. 30cm	Available Phosporus[8] a. 0-30cm b. 30cm	Exch. Potassium[9] a. 0-30cm b. 30cm	Reaction (pH) a. 0-30cm b. 30cm	Land Capability a. for Paddy b. for Upland Crop	Area (ha)
	15.Nam Len (NaL)	1.Reddish Brown Lateritic soils 2.Ultic Paleustulf 3.Ferric Acrisols	2-8	very deep	a. sandy clay loam b. clay loam	a. dark brown b. reddish brown	a. moderate fine to medium sub-angular blocky b. moderate medium sub-angular blocky	a. moderately well b. moderate c. medium	medium	a. high b. high	a. medium b. medium	a. moderately low b. moderately low	a. high b. medium	a. 5.5-6.5 b. 4.5-5.5	a. Vt b. IIm	23,400
	16.Wang Chomphu (Wc)	1.Grumsols 2.Typic Chromustert 3.Chromic Vertisols	2-8	very deep	a. clay b. clay	a. very dark grayish brown b. yellowish brown	a. moderate medium sub-angular blocky b. weak to moderate blocky	a. moderately well b. slow c. medium to rapid	medium	a. very high b. very high	a. high b. high	a. medium b. low	a. very high b. high	a. 7.0-8.0 b. 7.0-8.0	a. Vt b. IIm	550
	17.Mae Rim Complex (Mr-C)	1.Red Yellow Podzolic soils 2.Oxic Paleustult 3.Ferric Acrisols	4-20	shallow	a. sandy loam b. sandy clay loam	a. grayish brown b. reddish brown	a. weak fine sub-angular blocky b. very weak fine sub-angular blocky	a. well b. moderate c. medium to rapid	medium	a. moderately low b. low	a. very low b. very low	a. low b. low	a. medium b low	a. 4.5-6.0 b. 4.5-6.0	a. Vts b. IIIes	6,690
Dissected Erosion Surface and Hills	18.Muak/Li/ Bang Chong Association (Ml/Li/Bg)	1.Reddish Brown Lateritic soils 2 Lithic Haplustalf 3.Ferric Luvisols	4-20	shallow	a. loam b. silty clay loam	a. dark reddish brown b. reddish brown to red	a. moderate very fine sub-angular blocky b. moderate very fine to medium sub-angular blocky	a. well b. moderate c. rapid	medium	a. high b. high	a. medium b. medium	a. moderately low b. medium	a. high b. medium	a. 5.5-7.0 b. 5.0-6.5	a. Vt b. IIm	4,820
TOTAL																74,800

FOOTNOTES

/1 Classification:

(1) National : Based on "Major Soils of Southeast Asia", by R. Dudal and F.R. Moorman, Jour. of Trop. Geoq. Vol. 18, 1964

(2) USDA (1975) : Soil Taxonomy, Agricultural Handbook No. 436

(3) FAO/UNESCO : Soil Map of the World, Vol. 1 (Legend), 1974.

/2 Effective Soil Depth:

Rating	Range (cm)
Very Shallow	< 25
Shallow	25 - 50
Moderately deep	50 - 100
Deep	100 - 150
Very deep	> 150

/3 Texture, Soil Color, Structure:

These are based on the standard terms as defined in the USDA Soil Survey Manual, Agricultural Handbook No. 18, 1951.

/4 Drainage:

Ratings are described following the standard terms as defined in the USDA Soil Survey Manual.

Permeability:

Definition of ratings is as follows:

Ratings	Hydraulic Conductivity (cm/hr.)
Slow	< 0.5
Moderate	0.5 - 15
Rapid	> 15

Surface Runoff:

Definition of ratings is as follows:

Slow : Surface water flows away so very slowly that free water lies on the surface for considerable periods or immediately enters the soil. Much of water either passes through the soil or is last to evaporation. Soils are subject to little or no erosion hazard.

Medium : Free water stagnants on the soil surface for only short period. Erosion hazards are slight or moderate.

Rapid : A large proportion of precipitation moves rapidly over the soil surface. Erosion hazards are serious.

/5 Organic Matter:

Rating	Range (%)
Very low	< 0.5
Low	0.5 - 1.0
Moderately low	1.0 - 1.5
Medium	1.5 - 2.5
Moderately high	2.5 - 3.5
High	3.5 - 4.5
Very high	> 4.5

/6 Cation Exchange Capacity (CEC):

Rating	Range (%)
Very low	< 3
Low	3 - 5
Moderately low	5 - 10
Medium	10 - 15
Moderately high	15 - 20
High	20 - 30
Very high	> 30

/7 Base Saturation Degree:

Rating	Range (%)
Low	< 35
Medium	35 - 75
High	> 75

/8 Available Phosphorus:

Rating	Range (ppm)
Very low	< 3
Low	3 - 6
Moderately low	6 - 10
Medium	10 - 15
Moderately high	15 - 25
High	25 - 45
Very high	> 45

/9 Available Potassium:

Rating	Range (ppm)
Very low	< 30
Low	30 - 60
Medium	60 - 90
High	90 - 120
Very high	> 120

SOIL CLASSIFICATION SUMMARY FOR SUB-PROJECT AREAS

(Unit: Rai)

Land Category	National Soil Classification	Soil Series	Sri Chan Service Area	Pasak Left Bank Service Area	Huai Khon Kaen Area	Huai Yai Area	Khlong Chaliang Lab Area	Total	%
Flat Alluvial Plain	Hydromorphic Alluvial Soils	(1) Lom Sak (La)	2,450	37,380	13,480	7,010	500	60,820	53.7
		(2) Chaliang Lab (Cl)	-	-	2,550	-	-	2,550	2.3
		(3) Tha Phon (Tn)	5,330	-	-	-	-	5,330	4.7
		(4) Ban Pod (Bpo)	-	-	5,370	-	-	5,370	4.7
Low Terraces and Fans	Low Humic Grey Soils	(5) Hang Dong (Hd)	-	-	-	-	590	590	0.5
	Hydromorphic Non-Calcic Brown Soils	(6) Nakhon Pathom (Np)	-	2,400	10,890	4,610	5,290	23,190	20.5
	Non-Calcic Brown Soils	(7) Dong Yang En (Don)	-	-	560	450	1,810	2,820	2.5
		TOTAL	7,780	40,690	32,740	12,070	8,190	101,470	89.6
		GROSS AREA	7,990	42,070	38,960	15,040	9,240	113,300	100.0

TABLE III-2

RESULTS OF SOIL ANALYSIS

National Soil Series	Horizon	Depth (cm)	Particle Size Analysis			pH		Conductivity (micro mho)	$CaCO_3$ (%)	Carbon (%)	Nitrogen (%)	Exchangeable Bases (meq./100 gr)					CEC (meq./100 gr)	Base Saturation (%)	P (ppm)	K (ppm)
			Sand	Silt	Clay	H_2O	KCL					Ca	Mg	K	Na	Sum				
I. Hydromorphic Alluvial Soils																				
Lom Sak (La)	Ap	0-13	4.2	59.7	36.1	6.2	5.4	20.0	3.5	1.99	-	17.7	8.4	0.2	0.4	26.4	38.4	69	27.0	157
	B1	13-25	3.4	57.9	38.4	7.0	5.6	12.0	4.2	1.32	-	18.6	7.6	0.1	0.5	26.8	35.2	76	19.6	90
	B21	25-39	3.7	56.9	39.3	6.9	5.5	10.0	3.9	1.21	-	17.9	8.4	0.1	0.5	26.9	35.9	75	20.8	84
	B22	39-61	4.3	48.0	47.7	6.7	5.1	10.5	1.8	1.16	-	15.9	11.3	1.0	0.8	29.0	39.6	73	16.9	90
	B23	61-100	1.8	44.0	54.2	6.2	5.0	14.0	3.4	0.81	-	11.5	13.2	0.1	1.4	26.2	38.6	68	11.2	90
Chaliang Lab (Cl)	Apg	0-16	25.0	56.0	19.0	5.6	4.6	70.0	0.8	0.73	-	6.1	1.2	0.1	0.3	7.7	13.3	58	10.5	39
	B21g	16-51	11.0	59.0	30.0	6.1	4.9	52.0	0.8	0.34	-	6.7	2.1	0.1	0.4	9.3	15.0	62	12.7	42
	B22g	51-100	22.0	53.0	25.0	6.2	5.0	38.0	0.5	0.17	-	4.9	2.9	0.1	0.5	8.4	13.2	64	20.8	39
Tha Phon (Tn)	Ap	0-8	15.0	46.4	38.7	6.5	5.6	20.0	3.9	1.85	-	9.8	18.3	0.1	0.8	29.0	37.5	78	36.0	84
	A11	8-24	13.7	50.2	36.1	7.2	6.0	18.0	3.7	1.79	-	14.8	14.5	0.1	1.0	30.4	37.0	82	40.7	75
	B21	24-52	11.8	47.0	41.3	7.4	5.7	13.5	3.7	1.18	-	15.0	14.1	0.1	1.1	30.2	37.1	82	20.1	75
	B22	52-110	21.1	36.3	42.6	7.7	5.9	14.0	2.2	0.71	-	14.6	12.3	0.1	1.8	28.8	34.1	84	8.2	72
Ban Pod (Bpo)	A1	0-10	17.0	26.0	57.0	6.6	5.6	54.0	1.6	1.66	-	26.8	5.3	0.3	0.7	33.1	46.4	71	4.4	72
	B1	10-46	8.6	13.9	77.5	6.3	4.6	19.8	2.1	0.61	-	27.4	4.2	0.2	2.2	34.0	48.5	70	1.3	43
	B2	46-100	8.6	22.4	69.0	7.1	5.9	42.0	2.0	0.40	-	30.0	4.6	0.1	3.5	38.5	47.0	82	1.2	46
II. Low Humic Gley Soils																				
Hang Dong (Hd)	Apg	0-7	2.3	43.7	54.0	5.4	4.3	44.0	-	1.79	-	5.4	2.6	0.1	0.3	8.4	17.9	47	29.8	70
	A12g	7-18	6.5	54.1	39.4	5.3	4.9	27.5	-	1.30	-	5.4	3.1	0.1	0.3	8.9	15.4	58	6.4	61
	B1g	18-20	6.5	40.6	52.9	6.7	5.5	21.3	-	0.54	-	5.8	3.9	0.1	0.3	10.2	13.8	73	3.1	72
	B21tg	20-74	4.8	35.9	59.3	7.5	6.4	39.0	-	0.36	-	5.5	7.5	0.1	0.3	13.4	15.0	85	4.8	70
	B22tg	74-120	3.8	29.8	66.4	7.9	6.5	50.0	-	0.26	-	11.5	11.5	0.1	0.3	12.8	14.9	85	5.9	67
III. Hydromorphic Non-Calcic Brown Soils																				
Nakhon Pathom (Np)	Ap	0-10	8.9	44.2	46.9	6.1	5.3	80.0	3.2	1.33	-	14.0	3.9	0.1	0.3	18.3	25.5	72	38.4	123
	B1	10-28	7.9	51.5	40.6	6.5	5.6	65.0	2.9	1.14	-	15.0	4.3	0.1	0.3	19.7	25.6	35	39.8	123
	B21t	28-52	8.5	31.5	60.0	7.8	6.6	42.0	3.4	0.76	-	15.1	3.7	0.1	0.3	19.2	21.6	89	23.5	108
	B22t	52-	7.5	43.8	48.7	7.5	6.3	25.5	1.5	0.38	-	13.0	5.7	0.1	0.3	19.1	21.9	87	12.7	132
IV. Non-Calcic Brown Soils																				
Don Yang Er (Don)	A1	0-10	15.5	70.0	4.5	6.1	5.8	90.0	0.2	1.73	-	10.3	3.4	0.5	0.3	14.5	21.9	66	17.2	193
	A2	10-23	15.0	62.5	22.5	4.6	3.6	20.0	0.3	0.86	-	4.3	2.5	0.1	0.3	7.5	18.6	40	11.2	60
	B1	23-46	15.0	60.5	25.0	5.4	3.5	10.0	0.3	0.42	-	4.0	2.9	0.2	0.3	7.4	18.0	41	14.4	66
	B21t	46-67	14.0	54.5	30.5	5.6	3.9	10.5	1.0	0.37	-	5.3	3.6	0.1	0.3	9.3	20.1	46	18.0	63
	B22t	67-100	14.0	53.0	33.0	6.0	4.2	9.6	0.7	0.26	-	5.9	3.4	0.1	0.4	9.8	18.1	54	19.0	57

TABLE III-3

SPECIFICATION FOR LAND CLASSIFICATION

Classification Characteristics	Upland			Rice-Land		
	U1	U2	U3	R1	R2	R3
Soil Texture	SL-CL	LS-C(p) (LS<30 cm)	LS-C(sp) (LS<60 cm)	CL-C(vsp) (CL<30 cm)	SL-C(vsp) SL<15 cm L<30 cm CL>30 cm	LS-C(vsp) LS<15 cm
Depth of Soil	150 cm	120 cm	90 cm	90 cm	60 cm	30 cm
p^H (Paste)	5.5 - 8.0	5.0 - 8.5	4.5 - 8.5	5.0 - 8.0	4.5 - 8.5	4.0 - 8.5
ECe x 10^3	<4.0	<6.0	<8.0	<4.0	<6.0	<8.0
Exchangeable Sodium meg/100g	<2.0	<2.0	<3.0	<3.0	<4.0	<4.0
Water Holding Capacity in 120 cm depth	15 cm	11 cm	8 cm	N.A.	N.A.	N.A.
Topography						
Relief	Smooth	Uneven	Rough	Smooth	Uneven	Rough
Slope	<2 %	<4 %	<6 %	<2 %	<4 %	<4 %
Levelling Requirement	Low	Medium	High	Low	Low	Medium
Gravel or Rock	Few	Few	Some but tillable	Few	Few	Some but tillable
Rock Removal	None	None	Some	None	None	Some
Trees or Brush Cover	Slight Clearing	Moderate Clearing	Heavy Clearing	Slight Clearing	Moderate Clearing	Heavy Clearing
Drainage						
Surface	Good	Good-Fair	Fair-Good	Good	Good-Fair	Fair-Poor
Sub-surface	Good	Good-Fair	Fair-Good	Poor	Good-Fair	Good
Flood	None	None	Occasional	Infrequent Damaging Floods	Periodic Damaging Floods	Annual Damaging Floods

Note: Class 6 non-arable - these include all lands which do not meet the minimal requirement for classess 1, 2 & 3.

LAND CLASSIFICATION SUMMARY BY AREAS AND CLASSES (IN RAI)

Land Class	Sri Chan Service Area			Pasak Left Bank Service Area			Huai Khon Kaen Service Area			Huai Yai Service Area			Khlong Chaliang Lab. Service Area			Total Gross Area	Total Irrigable	
	Gross Area	Irrigable Area	Percent. of Irrigable Area	Gross Area	Irrigable Area	Percent. of Irrigable Area	Gross Area	Irrigable Area	Percent. of Irrigable Area	Gross Area	Irrigable Area	Percent. of Irrigable Area	Gross Area	Irrigable Area	Percent. of Irrigable Area		Area	%
R1 : U2sd/R1	3,500	3,500	58.3	22,930	22,930	72.9	13,850	13,850	49.2	7,250	7,250	64.4	5,370	5,370	71.6	52,900	52,900	62.8
R2 : U3sdf/R2f	4,030	2,500	41.7	10,700	8,510	27.1	-	-	-	-	-	-	-	-	-	14,730	11,010	13.0
R3 : U2st/R3st	-	-	-	3,060	-	-	320	270	0.9	-	-	-	-	-	-	3,380	270	0.3
R3 : U2t/R3st	460	-	-	1,580	-	-	7,550	2,400	8.4	2,650	680	6.0	2,750	1,290	17.2	14,990	4,370	5.2
U2/R2 : U2s/R2s	-	-	-	850	-	-	4,980	4,980	17.7	640	640	5.7	100	100	1.3	6,570	5,720	6.8
U2/R2 : U2sd/R2s	-	-	-	820	-	-	5,790	5,790	20.6	1,930	1,930	17.2	-	-	-	8,540	7,720	9.1
U2/R2 : U2st/R2t	-	-	-	170	-	-	360	360	1.3	750	750	6.7	740	740	9.9	2,020	1,850	2.2
U2/R2 : U2st/R2st	-	-	-	80	-	-	540	540	1.9	-	-	-	-	-	-	620	540	0.6
U1 : N.A.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
U2 : N.A.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
U3 : U3st/R6st	-	-	-	1,770	-	-	4,410	-	-	1,500	-	-	280	-	-	7,960	-	-
Class 6 & Others	-	-	-	110	-	-	1,160	-	-	320	-	-	-	-	-	1,590	-	-
Total Irrigable Area	-	6,000	100.0	-	31,440	100.0	-	28,190	100.0	-	11,250	100.0	-	7,500	100.0	-	84,380	100.0
Total Gross Area	7,990	-	-	42,070	-	-	38,960	-	-	15,040	-	-	9,240	-	-	113,300	-	-

Remarks : Gross Area includes irrigable lands plus non-arable lands (class 6) and lands in right - of - way for roads, canals drainage channels, etc., and lands in villages and settlement.

AGRICULTURAL LIMITATIONS AND SUGGESTED LAND-USE FOR EACH LAND CLASS

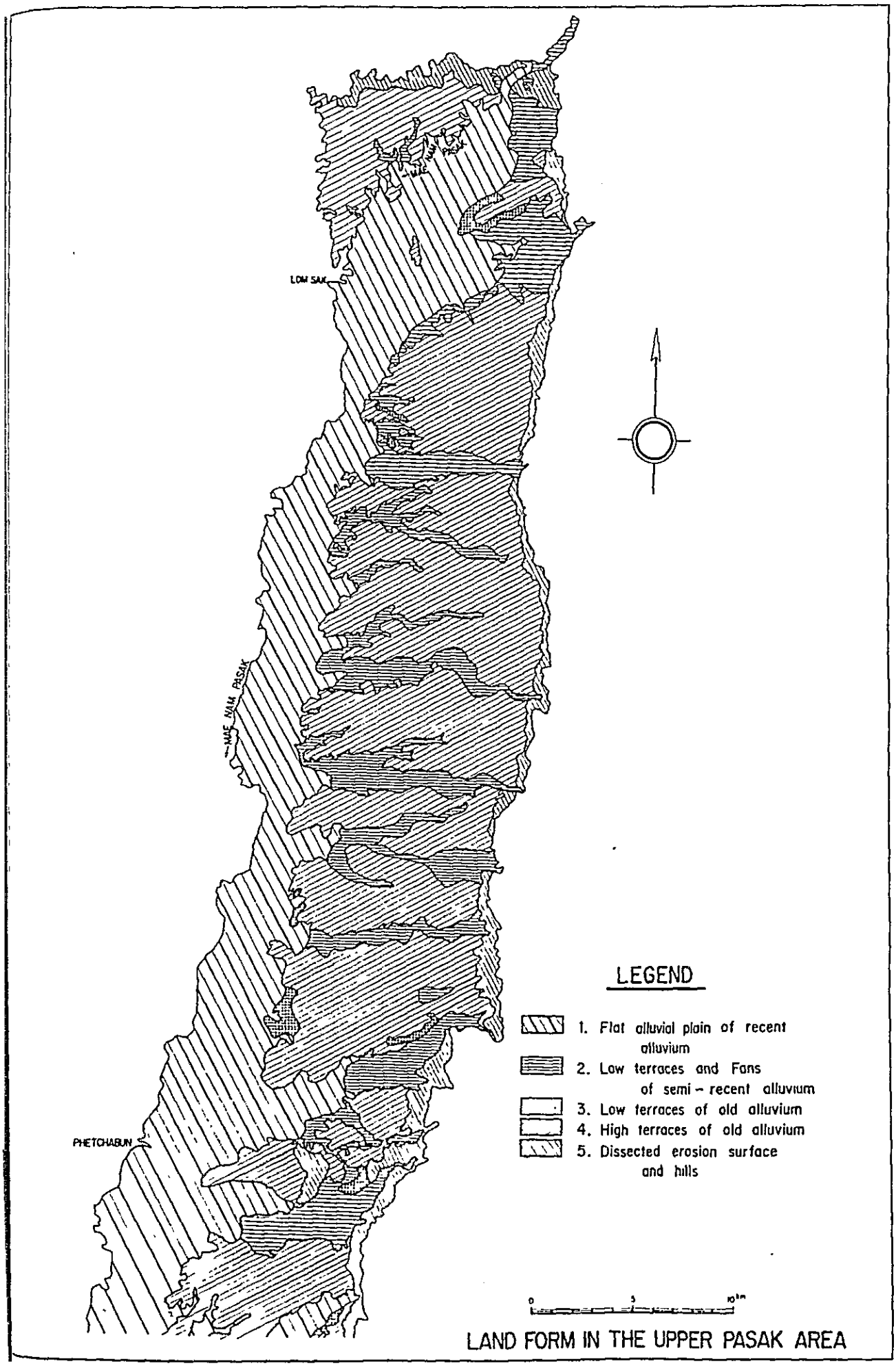
Land Class	Area (rai)	Agricultural Limitation	Suggested Land-use	Management Factors
R1 : U2sd/R1	52,900	Heavy texture, poor drainate, moderate fertility	Double cropping of rice or rainy season paddy and upland cropping after rice with tobacco and beans	Drainage inprovement, use of fertilizers on the basis of experimentation and rotational cropping aimed at up-grading the fertility level of soil
R2 : U3sdf/R2f	14,730	Heavy texture, poor drainage, liability to flooding, moderate fertility	- do -	Flood control, drainage improvement, use of fertilizer
R3 : U2st/R3st R3 : U2t/R3st	18,370	Uneven topography, variable texture and drainage, low fertility	Multiple cropping of rice and upland crops in small scale	Adequate water supplies and fertilization, land levelling and laying out of small fields
U2/R2 : U2s/R2s	6,570	Low fertility, relatively heavy texture	Double cropping of rice or rice cultivation combination with upland crops under irrigation	rotational cropping for up-grading the fertility level of soil and adequate fertilization
U2/R2 : U2sd/R2s	8,540	Heavy texture, moderately poor drainage, depleted in nutrients	- do -	- do -
U2/R2 : U2st/R2t	2,020	Uneven topography and low fertility	Small scale rice cultivation and rotational upland cropping	Land levelling or laying out of small plots, adequate fertilization
U2/R2 : U2st/R2st	620	Uneven topography, light texture and relatively high infiltration, low fertility	- do -	- do -
U3 : U3st/R6st	7,960	Uneven topography, shallow gravelly soils, low fertility, lateritic	Forest	

SOIL INFILTRATION RATES

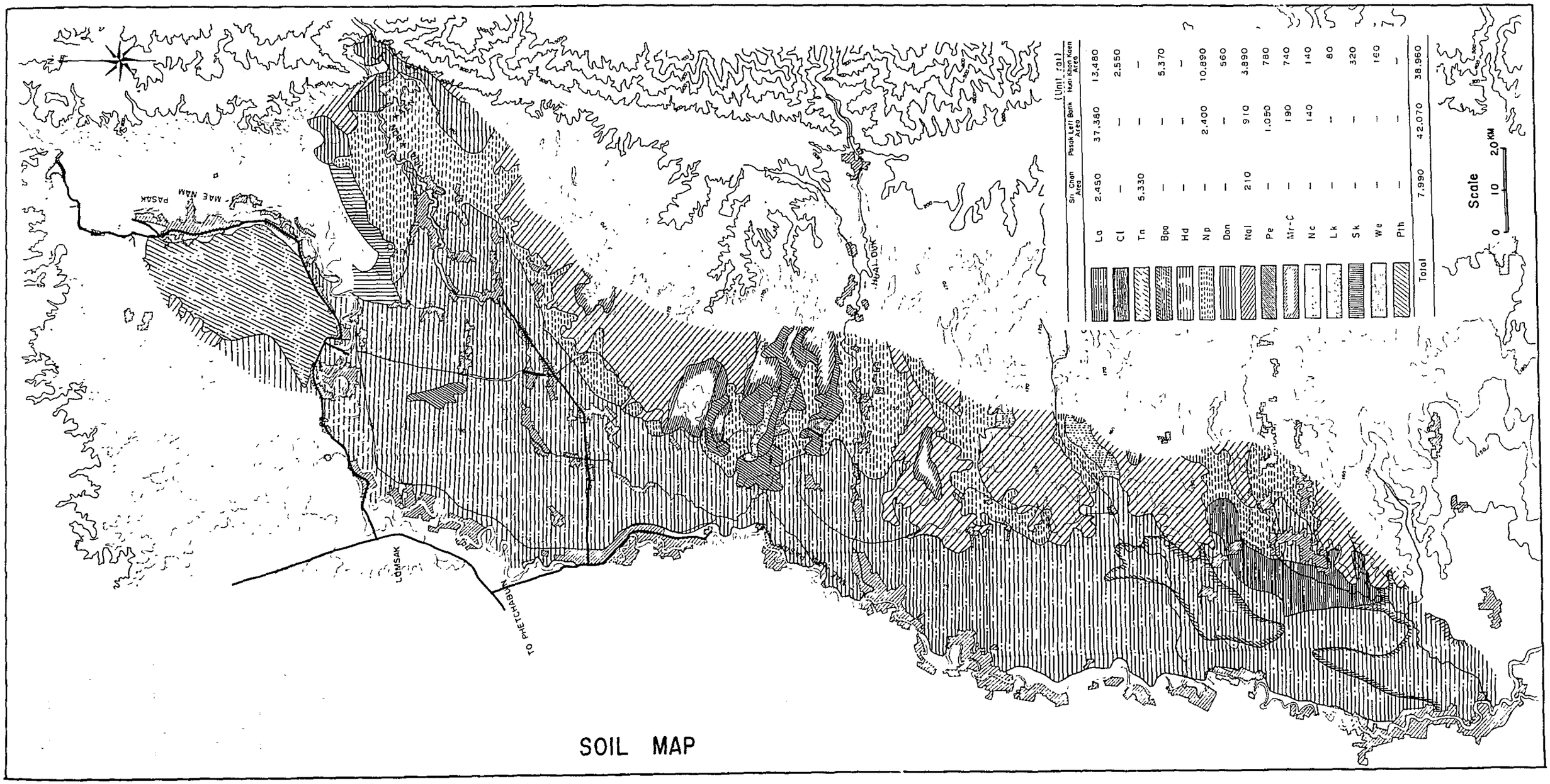
(PARTIAL INFILTRATION PER HOUR)

SUB-PROJECT AREA		HUAI SADUANG YAI AREA		HUAI KHON KAEN AREA		HUAI YAI AREA		KLONG CHALIANG LAB AREA	
Soil Series		Dong Yang En		Lom Sak		Nakhon Pathom		Ban Pod	
Land Class		U2t/R3st		U2s/Rl		U2sd/Rl		U2sd/Rl	
Time Between Reading	Cumulative Time	Hole 1		Hole 2		Hole 3		Hole 4	
		0 cm	20 cm	0 cm	20 cm	0 cm	22 cm	0 cm	23 cm
(min)	(min)								
0	0								
5	5	0.1	0.2	0.6	1.0	1.5	0.3	3.0	0.2
5	10	0.2	0.1	0.2	0.2	0.6	0.0	0.8	0.0
10	20	0.1	0.1	0.2	0.3	0.9	0.1	1.2	0.3
10	30	0.1	0.1	0.0	0.1	0.7	0.0	0.9	0.1
15	45	0.2	0.2	0.0	0.3	0.9	0.0	0.9	0.1
15	60	0.2	0.1	0.1	0.1	0.9	0.1	0.9	0.1
30	90	0.2	0.1	0.0	0.2	1.6	0.1	1.2	0.2
30	120	0.3	0.1	0.2	0.3	1.3	0.0	0.8	0.1
30	150	0.1	0.2	0.0	0.2	1.3	0.1	0.6	0.0
30	180	0.1	0.1	0.1	0.1	1.3	0.1	0.7	0.1
60	240	0.3	0.1	0.1	0.4	1.5	0.1	1.2	0.2
Cumulative Infiltration		1.9	1.4	1.5	3.2	12.5	0.9	12.2	1.4

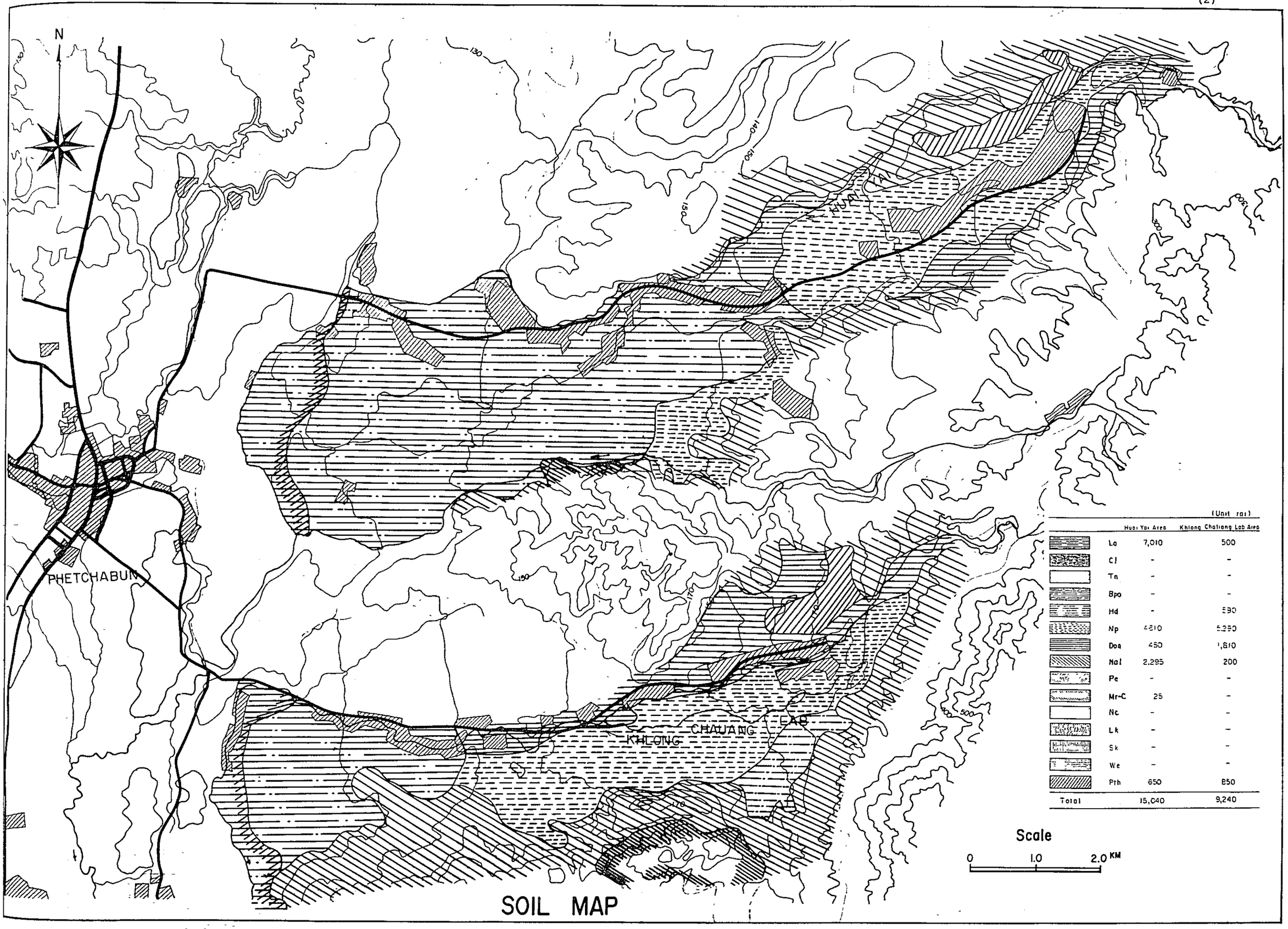
TABLE III-7



LAND FORM IN THE UPPER PASAK AREA


(Unit : rai)
Sri Chon Area
Pasak Left Bank Area
Hua Khon Kaen Area
La 2,450 37,380 13,480
Cl — — 2,550
Tn 5,330 — —
Bpo — — 5,370
Hd — — —
Np — 2,400 10,890
Don — — 560
Nal 210 910 3,890
Pe — 1,050 780
Mr-C — 190 740
Nc — 140 140
Lk — — 80
Sk — — 320
We — — 160
Plh — — —
Total 7,990 42,070 38,960
Scale
0 10 20 KM
MAE NAM PASAK
HUAI DUK
LOMSAK
TO PHETCHABUN

SOIL MAP



(Unit rai)

		Huai Yai Area	Khlong Chaiang Lab Area
	La	7,010	500
	Cl	-	-
	Tn	-	-
	Bpo	-	-
	Hd	-	590
	Np	4810	5,250
	Doa	450	1,810
	Nal	2,295	200
	Pe	-	-
	Mr-C	25	-
	Nc	-	-
	Lk	-	-
	Sk	-	-
	We	-	-
	Prh	650	850
Total		15,040	9,240

LAND CLASSIFICATION MAP

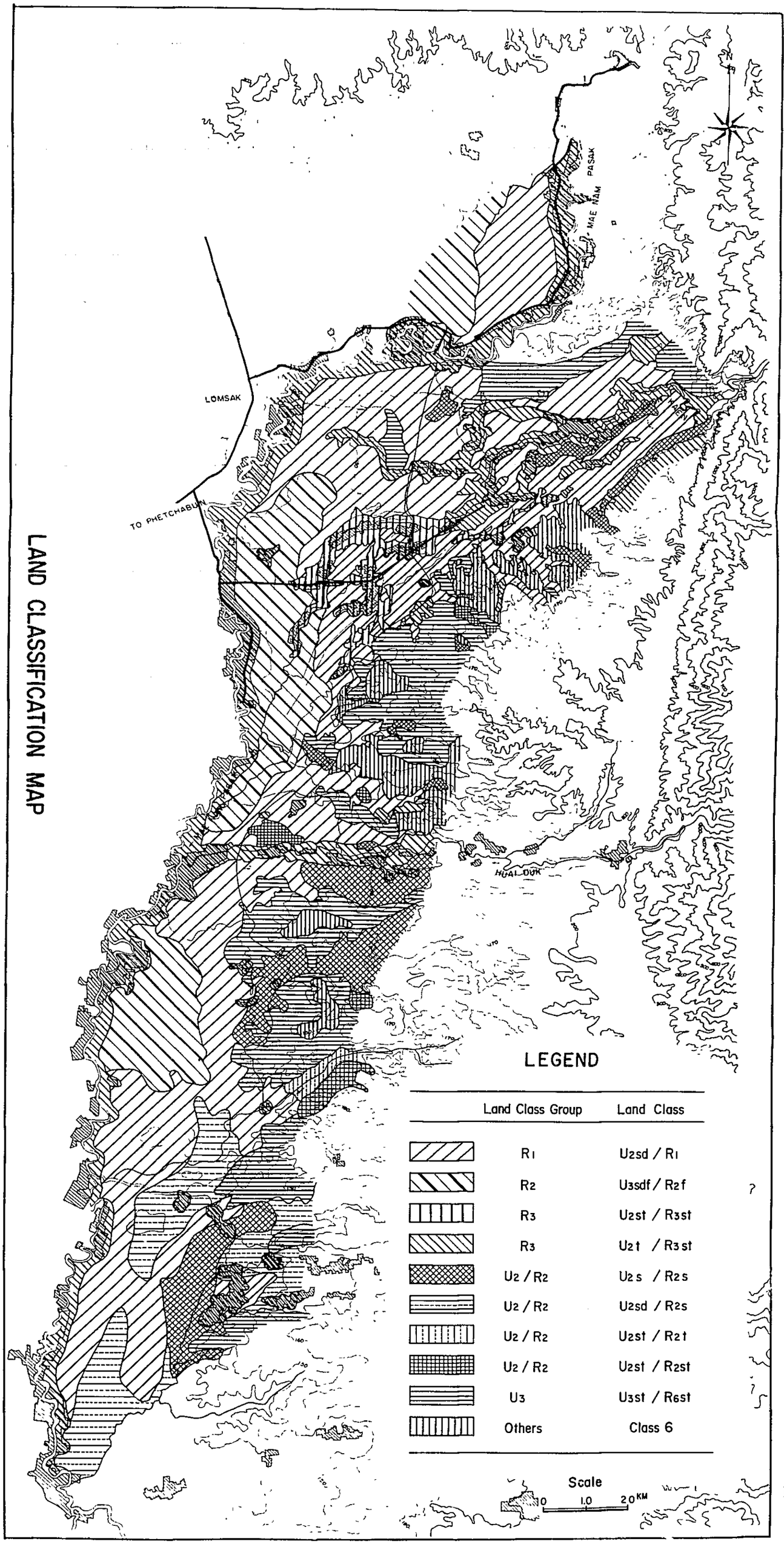
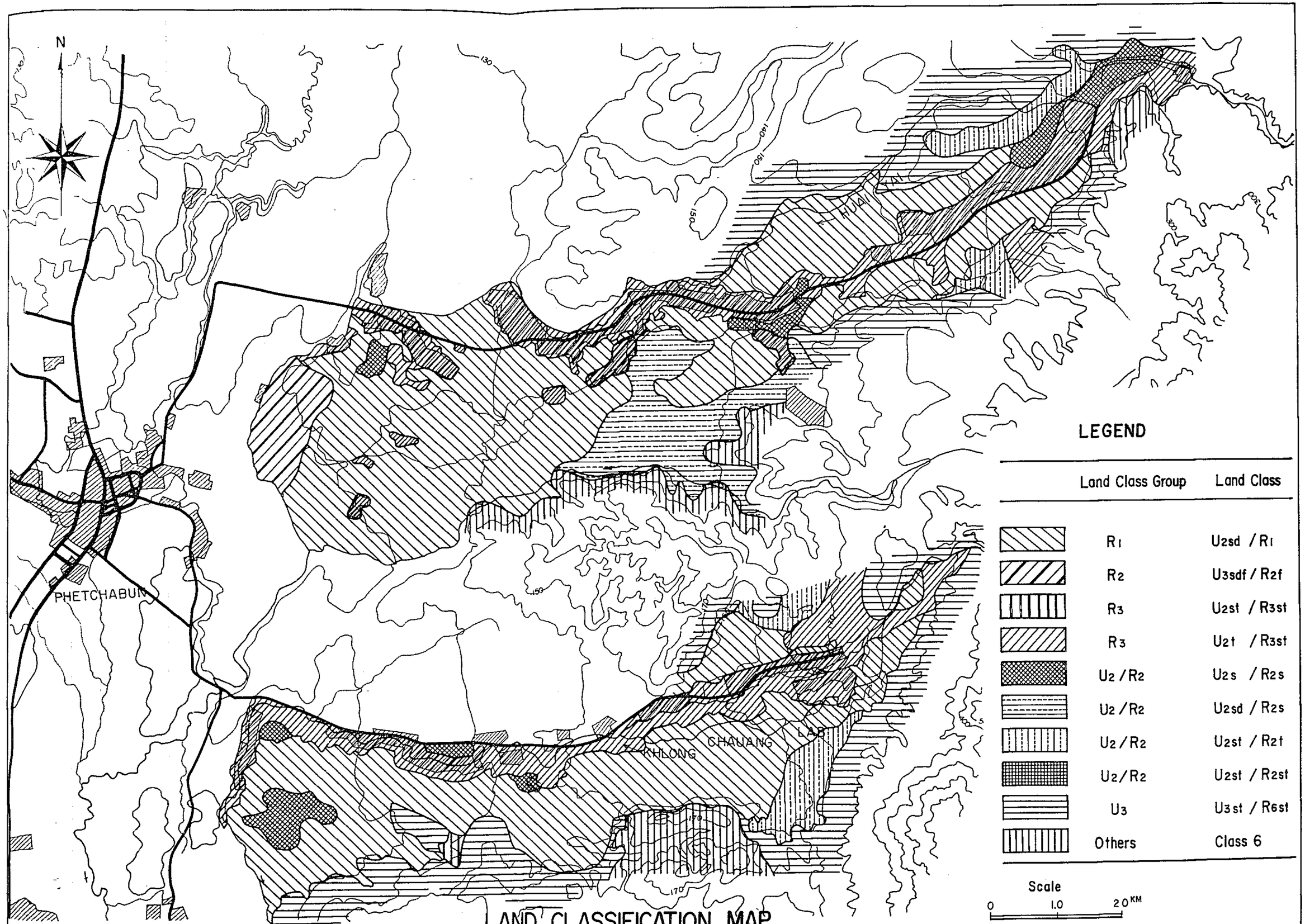


FIG. III-3 (1)



LAND CLASSIFICATION MAP

ANNEX IV
AGRICULTURE AND AGRO-ECONOMY

ANNEX - IV

AGRICULTURE AND AGRO-ECONOMY

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ANNEX - IV

AGRICULTURE AND AGRO-ECONOMY

1. PRESENT CONDITION IN THE PROJECT AREA

1.1 Rural Organization

Phetchabun province is administratively divided into 8 districts (Amphoe). These districts are further sub-divided into 78 sub-districts (Tambon). Under the sub-districts, there are 753 villages (Muban) which are the basic unit of administrative structure in Thailand. Average number of sub-district in one district is about 10. One sub-district has about 10 villages on an average in the province.

The project area is covered Lom Sak District and Phetchabun District. Lom Sak District has 20 sub-districts and 172 villages. Phetchabun District has 16 sub-districts and 123 villages. Average number of villages in one sub-district is 9 in Lom Sak District and 8 in Phetchabun District respectively. Out of the above sub-districts and villages, 12 sub-districts and 105 villages are concerned with the project area. The number of district, sub-district and villages in Phetchabun Province are as shown in the following table.

	Phetchabun Province	District			Project area concerned		
		Lom Sak	Phetchabun	Total	Lom Sak	Phetchabun	Total
District	8	1	1	2	1	1	2
Sub-district	78	20	16	36	9	3	12
Village	753	172	123	295	81	24	105

Source: Statistical Report of Province, 1981
Amphoe Lom Sak and Phetchabun Offices, 1982

1.2 Population and Family

As seen in the Table IV-1, the total population in the Lom Sak and Phetchabun Districts is reported to be about 150 x 10^3 or 88.8 persons/km^2 and 157 x 10^3 or 50.8 persons/km^2 in 1981. The average annual growth rate is about 2.61% in Lom Sak District and about 2.72% in Phetchabun District from 1970 to 1981 respectively.

According to the data and information collected from Agricultural Offices in Lom Sak and Phetchabun and village survey, total population in the project area is estimated at about 70,000 in 1981.

Distribution of farm population and farm house-hold in each service area are estimated as follows based upon the data from field survey.

Sub-Area	Farm Population	Farm House-hold	Population per Farm House-hold
Sricham Service Area	3,380	610	5.5
Pasak Left Bank Service Area	17,740	3,230	5.5
Huai Khon Kaen Service Area	23,010	3,540	6.5
Huai Yai Service Area	6,110	1,110	5.5
Khlong Chaliang Lab Service Area	4,350	790	5.5
Average or Total	54,590	9,280	5.9

In the project area, the farm population is about 55,000 persons or 80% of the total population. The total number of farm house hold in the project area is estimated at about 9,300 in 1981. Average family size is estimated at about 5.9 persons and available labor forces are about 2 - 3 persons.

1.3 Land Tenure and Holding

The Government of Thailand promulgated "Agricultural Land Reform Act" in 1975 aiming at better allocation of land resources and redeeming lands for farm. Since then, the land ownership has substantially been improved.

The following table shows the land tenure situation in the Phetchabun Province, Lom Sak and Phetchabun Districts.

	Phetchabun Province				Lom Sak District				Phetchabun District			
	No. of Household		Area		No. of Household		Area		No. of Household		Area	
Description	(No.)	(%)	(10^3 rai)	(%)	(No.)	(%)	(10^3 rai)	(%)	(No.)	(%)	(10^3 rai)	(%)
Owner farmer (Owned)	69,690	84.2	2,098	85.0	12,460	90.8	262	93.2	11,800	78.3	330	77.1
Tenant (Rented)	6,890	8.3	138	5.6	490	3.6	4	1.4	880	5.8	16	3.7
Partial tenant	5,110	6.2	212	8.6	690	5.0	14	5.0	1,760	11.7	68	15.9
Others	1,080	1.3	21	0.8	80	0.6	1	0.4	630	4.2	14	3.3
Total	82,770	100.0	2,469	100.0	13,720	100.0	281	100.0	15,070	100.0	428	100.0

Source: - 1978 Agricultural Census Report, Thailand.
- National Statistic Office, Office of the Prime Minister.

As seen in the above table, owner farmer is predominant in Phetchabun Province occupying about 84% of the total households and about 85% of the total area in 1978 respectively. In Lom Sak and Phetchabun Districts, owner farmer occupies about 91% and 78% of the total households and about 93% and 77% of the total area in 1978 respectively.

The following table shows the land holding by farm size in Phetchabun Province in 1963 and 1978.

1963					1978				
Size of Farmland (rai)	No. of Farm (10^3)	(%)	Area of Farm (10^3rai)	(%)	Size of Farmland (rai)	No. of Farm (10^3)	(%)	Area of Farm (10^3rai)	(%)
					Under 2	0.9	1.1	0.2	0
2 - 6	7.2	15.5	27.1	3.1	2 - 6	5.8	7.0	22.4	0.9
6 - 15	17.1	36.7	165.9	18.8	6 - 15	17.3	20.7	172.2	7.0
15 - 30	13.9	29.8	283.1	32.0	15 - 30	26.7	32.0	553.3	22.4
30 - 45	5.0	10.7	172.6	19.5	30 - 50	19.3	23.1	694.7	28.1
45 - 60	2.0	4.3	99.7	11.3	50 - 60	4.9	5.9	253.7	10.3
60 - 140	1.3	2.8	103.6	11.7	60 - 140	7.8	9.4	618.9	25.1
Over 140	0.1	0.2	31.7	3.6	Over 140	0.7	0.8	154.0	6.2
Total	46.6	100.0	883.7	100.0	Total	83.4	100.0	2,469.4	100.0

Source: Agricultural Census in 1978

From the above table, approximately 76% of farmers are in the range from 6 to 50 rai in case of 1978, which is rather even distribution of land, and particularly the range of 15 - 30 rai occupies the highest percent. About 10% of large land holding farmers of more than 60 rai, however, still occupy about 30% of the total farmland in 1978.

The average farm size in Lom Sak District and Phetchabun District is about 19.2 rai and about 25.1 rai respectively in 1982 according to the data collected from Phetchabun Province. These figures are smaller than those in 1978; 20.4 rai in Lom Sak District, 28.4 rai in Phetchabun District, according to Agricultural Census Report, Thailand. These reductions may mainly be caused by population increase in recent years.

Most of farmers have their farmlands scatteredly and their plot sizes are rather small; 1 - 2 rai in most cases. This land holding situation will disturb the farming in various aspects such as mechanized farming, transportation of farm inputs and outputs, etc.

1.4 Present Land Use

The land use survey was carried out in and around the project area. For the preparation of land use map (Fig. IV-1), the data and information collected from Agricultural Offices in Phetchabun and Lom Sak Districts and the land use map prepared by RID are fully referred to. The following is a brief description of present land use condition in each service area (Table IV-2).

(1) Sri Chan Service Area

The Sri Chan area, 8,000 rai, is located 10-km northeast of the Lom Sak municipality. The area extends north to south along the right bank of the Pasak river. Most part of the area comprises flat alluvial plain with the elevation around 150 m.

The area is provided with primitive irrigation facilities constructed by farmers themselves, and irrigated paddy cultivation is practiced in 5,000 rai, about 63% of the total area, though stable paddy cultivation cannot be expected even in the rainy season owing to insufficient irrigation water in some years. About 1,000 rai are cultivated with upland crops such as mungbeans, tobacco and maize, and the remaining lands are mainly used as orchard garden and village yard.

(2) Pasak Left Bank Service Area

The area of 42,000 rai is located immediately east of the Lom Sak municipality and extends slenderly along the left bank of the Pasak river, and mainly comprises flat alluvial plain with the elevation ranging from 130 m to 150 m. The area is provided with the irrigation facilities comprising 100-m long diversion weir, 24.5-km long main canal and 34.4-km long lateral canals. Irrigated paddy cultivation is predominant in the area, but stable paddy cultivation cannot be expected even in the rainy season because of insufficient irrigation water in some years. About 26,000 rai or 62% of the total area are cultivated with paddy, and about 6,500 rai are cultivated with upland crops such as mungbeans, tobacco and maize. The remaining lands are mainly used as orchard garden and village yard.

(3) Huai Khan Kaen Service Area

The area, 39,000 rai, extends over along the east side of the Pasak Left Bank area and most of the area is flat land with the elevation ranging from about 130 to 170 m. Rain-fed paddy cultivation predominates in this area except some villages, where farmers have simple irrigation facilities, of which water resources are small streams or shallow wells, for the cultivation of paddy and upland crops such as tobacco and mungbeans. The cultivation area consists of about 20,000 rai or 51% of paddy fields and about 9,100 rai or 23% of upland fields. Unstable paddy cultivation is practiced even in the rainy season throughout the project area,

and yield of paddy is rather low with large variance from year to year. The remaining lands are mainly used as orchard garden and village yard.

(4) Huai Yai Service Area

The area is located in the southern part of the project area. Most of the area is flat with the elevation ranging from about 120 m to 180 m. No notable irrigation facilities exist throughout the project area and paddy-cultivated area largely varies from year to year. The cultivated lands in this area mainly consist of paddy fields with a total area of 10,900 rai; 72% of the total area, and upland fields with a total area of 540 rai; 4% of the total area. The remaining lands are mainly used as orchard garden and village yard.

(5) Khlong Chaliang Lab Sub-project Area

The area extends over the southern part of the project area with relatively flat land ranging from 120 m to 170 m in elevation. There is no notable irrigation facilities in the area at present, except in the upstream portion, where the village-level irrigation facilities exist. Out of total area of 9,240 rai, about 7,300 rai or 80% are used for paddy cultivation and 300 rai or 3% for upland crop cultivation. The remaining lands are mainly used as orchard garden and village yard.

1.5 Present Cropping Pattern and Farming Practices

1.5.1 Present Cropping Pattern

Paddy is the main crop in the project area, followed by mungbeans and tobacco. Rain-fed paddy cultivation predominates in this area except the Sri Chan and the Pasak Left Bank service areas, where irrigation farming is under practice. Four cropping patterns prevailing in the project area are shown in Fig. IV-2, of which data and information were obtained from Province and District Agricultural Extension Offices and through village survey, and confirmed with the present land use map.

Type-1 pattern is predominant in the Sri Chan and Pasak Left Bank service areas. Paddy is planted from the onset of the rainy season; normally early July, and harvested from November to December. The planting period of paddy varies from 2 to 2.5 months depending on the rainfall pattern. The dry season crops such as mungbeans and tobacco, though these crops are cultivated in a limited area, are mainly planted from January to February after the harvesting of rainy season paddy and harvesting from April to June in general. Maize is also planted in the service area in the dry season. The crop intensities in the past 11 years varied from 102% to 143% as shown in Table IV-3.

Type-2 pattern mainly prevails in the Huai Khon Kaen service area. Planting and harvesting periods of rainy season paddy are almost the same as those of the above-mentioned cropping pattern Type-1. Mungbeans and tobacco are cultivated in a limited area. These crops are planted after harvesting the rainy season paddy. Maize is also planted in a large area in the dry season.

Type-3 pattern is predominant in the Huai Yai service area. Rainy season paddy is planted from the middle of June to middle of August, but this period varies from year to year depending on the rainfall pattern. Harvesting period of the rainy season paddy is from the beginning of November to the end of December. After harvesting the rainy season paddy, mungbeans and tobacco crops are cultivated in a limited area under rain-fed condition. Maize is also planted in a limited area in the dry season.

Type-4 pattern is predominant in the Khlong Chaliang Lab service area. In the rainy season, paddy is planted from the middle of June to the middle of August in general, but this period also varies from year to year depending on the rainfall pattern. The harvesting period of rainy season paddy is from the beginning of November to the end of December. After harvesting of rainy season paddy, mungbeans and tobacco are planted in a limited area as the dry season crops. In a limited area, maize is also planted in the dry season.

The following table shows the cropping intensities of the respective cropping types:

	Type-1	Type-2	Type-3	Type-4
Paddy (L.V)	24.9%	28.9%	48.5%	49.0%
(H.Y.V)	41.5	28.9	19.4	19.6
Beans	16.6	7.2	7.8	9.8
Tobacco	12.5	7.2	1.9	4.9
Maize	17.0	27.8	3.0	2.0
Total	113	100	81	85

1.5.2 Farming Practices

(1) Paddy

In Thailand, paddy is cultivated mostly in the rainy season and in a limited area, about 6 percent of the total paddy fields, the dry season paddy is also cultivated. In general, paddy can be grown anytime throughout the year where the irrigation water is available.

The present farming practices in the project area are still conventional resulting in rather low yield of crops owing to the lack of effective irrigation facilities. Rain-fed cultivation prevails in all over the proposed irrigation development area except Sri Chan and Pasak Left Bank service areas.

Various varieties of paddy have been introduced to the project area in the recent years. These are:

Glutinous varieties	; San Pha Tawng, Kao Hom, Sang Lueng, Hom Pama, E-Dang, RD-2, RD-6
Non-glutinous varieties	; Hom Ma Li 105, Lueng Yai, Kao Ruang, Nang Mon, Kao Ta Haeng, RD-1, RD-7, RD-15

Among these varieties, Kao Hom, Hom Ma Li 105, RD-1 and RD-7 are predominant.

According to the farm economy survey together with village survey, high yield varieties introduced to the project area cover less than 50 percent of the whole area planted at present.

In general, cropping period of paddy in the project area is as follows:

Sowing period	Transplanting period	Harvesting period
June - July	July - August	November - December

Growing period of local varieties ranges from about 140 to 160 days and that of high yield varieties is from about 120 days to 135 days respectively.

Prior to transplanting of paddy seedling, plowing, harrowing and paddling are carried out mainly by using tractors and in a few cases, by buffalo or cattles at present.

Transplanting is made by hand. In some cases, this work is done by community group organized by neighbourers or extended family level at free of charge.

Fertilizer is seldom applied to paddy cultivation in the project area at present because of residual of fertilizer applied for tobacco cultivation in the dry season.

Green plant hopper, gall midge and rice stem borers of insects, and rice blast and bacterial leaf blight of diseases are considerably serious in paddy cultivation in the project area. In addition, rat damage is also serious in recent years throughout the project area according to data and information from the plant protection unit of Phitsanulok Province. A little amount of agro-chemicals; 0.1 liter/rai on an average, except rodenticides, is applied one or two times for a crop growing season as shown in Table IV-4.

Weeding is practiced by hand one or two times in a growing season.

Harvesting of paddy is done by hand using sickle. Stalk with panicle is cut about 50 cm long and laid down on the fields for 2 - 3 days to dry, and harvested paddy are spread over the threshing floor which is prepared in advance at the elevated place and then beaten with bamboo stick or against the floor for threshing, or let buffalo or cattles tramp over them. Pedal threshers are being introduced, and a few engine threshers are also introduced. Winnowing of husk is still practiced prevailingly in this region.

A large part of farming works is generally operated by the family labours except for transplanting and harvesting of paddy. Seasonal labours required are mainly supplied from small holder farmers and tenant farmers in the project area and partly come from the outside. Present labour requirement for paddy is shown in Table IV-4, and present paddy cultivation method in the project area is shown in Table IV-5.

(2) Mungbeans

Mungbeans are one of the predominant crops in the project area. At present, native varieties of mungbeans are predominantly cultivated in the area. The new variety of U-tong No. 1; high quality variety, has recently been introduced to the project area, but its cultivation area is limited.

In general, sowing period of mungbeans is from January to February after harvesting the rainy season paddy. Harvesting period of mungbeans is from April to May after 70 days - 80 days from sowing.

Fertilizing and weeding are not carried out in the project area in general, according to farm economy survey and village survey, but spray for pest control is commonly practiced (see Table IV-4). Threshing machines for harvested products have been introduced in some villages in recent years.

The prevailing cultivation method of mungbeans in the area is summarized in Table IV-5.

(3) Maize

In the Phetchabun province, maize is one of the most important crops and about 50% of total upland field is cultivated with maize in the dry season in 1979/80 according to the Agricultural Statistics of Thailand. In general, sowing period of maize is from March to July, and required seed amount is about 4 - 5 kg/rai. Harvesting period of maize is from June to July after 100 days - 120 days from sowing.

No fertilizing and weeding and a little amount of spraying are practiced in the project area according to farm economy survey and village survey in general (Table IV-4). Threshing machines for harvested products have been introduced in some villages in recent years. The prevailing cultivation method of maize in the project area is summarized in Table IV-5.

(4) Tobacco

Tobacco is one of the most important cash crops in the project area, and farmers have a long experience for tobacco crop cultivation.

Burkley variety of tobacco is prevailing in the project area; more than 95 percent of the total tobacco cultivation area. At present tobacco is mainly planted in paddy field after harvesting the rainy season paddy. Some villages have farmers' cooperative irrigation facilities, and some farmers have their own shallow well irrigation facilities for tobacco cultivation.

Growing period of Burkley variety ranges from about 120 to 150 days. Transplanting period of tobacco in the project area is from January to February and harvesting from April to June. Farmers in the project area have comparatively high cultivation techniques for tobacco, because the intensive guidance is being made by the field extension workers despatched from the Tobacco Monopoly Office and Agricultural Extension Office.

Weeding is commonly practiced about 2 - 3 times by manual labour. Fertilizer and agro-chemicals are applied usually. Especially spraying of agro-chemicals is carried out 3 to 4 times for a tobacco growing period (see Table IV-5).

Peak time of labour requirement for tobacco cultivation comes at harvesting time as seen in Table IV-4, and labour shortage is generally observed at this time. For this crucial condition, however, there are still rooms for the improvement of farming practices by modernizing the present cultivation method and by distributing the family labours effectively.

The prevailing cultivation method of tobacco is briefly explained in Table IV-5.

1.6 Crop Yield and Production

1.6.1 Crop Yield

Yield of paddy varies substantially with variety of paddy, availability of irrigation water, amount of farm inputs, etc. According to the farm economy survey and village survey, the yield varies from 180 kg/rai to 700 kg/rai in the project area. Such yield variation of paddy is considered to be caused by selection of variety, low contents of

organic matters in soils, less availability of irrigation and drainage facilities, conventional farming practices, less application of fertilizer and agro-chemicals, and insufficient agricultural support services. Particuarly in the rain-fed areas like the Huai Khon Kaen service area, Huai Yai service area and Khlong Chaliang Lab service area, paddy often encounters severe drought condition, resulting in considerably low yield. On the other hand, yield of paddy in the Sri Chan service area and Pasak Left Bank service area, where there exist irrigation facilities, is rather high as compared with those in the rain-fed area mentioned in the above.

Yields of upland crops such as maize, mungbeans and tobacco also vary substantially with the variety, soil fertility, rainfall pattern and applied quantities of farm inputs.

The present yields of major crops cultivated in the Phetchabun Province are estimated on the basis of data obtained from Agricultural Extension Office in Phetchabun Province, as given in the following table.

(Unit: kg/rai)

Major crops	1973/ 74	1974/ 75	1975/ 76	1976/ 77	1977/ 78	1978/ 79	1979/ 80	1980/ 81	1981/ 82	Average
Paddy (dry)	439	442	461	427	326	427	330	587	445	440
Maize	500	426	411	441	321	405	379	429	468	420
Mungbeans	118	158	99	91	78	91	93	141	125	110
Tobacco				301	300	307	300	299	300	300

Source: - Provincial Agricultural Extension Office, 1982
- Phetchabun Tobacco Monopoly Office, 1982

The above table shows the stagnant conditions of crop yields for recent 9 years, though the yields widely fluctuate from year to year due to wide variation of annual rainfall and unexpected damages caused by drought, flood, insects and diseases (Table IV-6). Further, the following table shows the present yields of major crops estimated on the basis of the data and information collected from the agricultural extension offices, village survey and farm economy survey:

(Unit: kg/rai)

	Rainy Season		Mungbeans	Maize	Tobacco
	L.V	H.Y.V			
Lom Sak District	440	650	123	433	285
Phetchabun District	420	550	172	430	300
Village Survey	440	600	120	490	350
Farm Economy Survey	480	610	100	380	330

Based on the above-mentioned data and information, the present yields of major crops in the respective service areas are estimated as shown in the following table.

(Unit: kg/rai)

	Sri Chan and Pasak Left Bank Service Area	Huai Khon Kaen Service Area	Huai Yai Service Area	Khlong Chaliang Lab Service Area
Paddy (L.V)	500	400	440	440
(H.Y.V)	650	550	550	550
Maize	420	420	420	420
Mungbeans	120	120	120	120
Tobacco	270	270	270	270

1.6.2 Crop Production

The present crop production of paddy and upland crops are estimated by multiplying the crop-planted area by the crop yields. In the estimation, it should be noted that rice production levels fluctuate from year to year. Table IV-7 shows the present cropping area and the present crop production in the respective service areas.

1.7 Marketing and Current Prices

1.7.1 Marketing Flow Structures

The marketing flow structures for farm inputs and outputs in Thailand are broadly categorized in three major classes; local market, assemble or central market and terminal market.

The local market exists in rural areas and does not require any purchasing or selling facilities. All the products are traded on the roads, in village yards or at the crop-fields. Many kinds of middlemen such as local merchant, broker, marketing cooperatives, factory, government agency (MOF and POW) and retailer, who keep close relationship with farmers through money lending and input supply, take part in the local markets.

The assembly market exists in the suburbs of towns, having fixed trading facilities. The provincial merchants, brokers, factory representatives and retailers take part in this market. These traders as collecting agents, buy the farm products directly from farmers or local merchants, and as money lenders, extend credits to local merchants. They also act as a price conductors between the local markets and the terminal market.

Bangkok is the terminal market, which is operated by large brokers, wholesalers, factory, representatives, cooperative federation (CMPF), government agencies (MOF and POW), exporters and retailers. This market also takes part in the trading activities as the export market and the reshipping market to local market or to assembly market. This market acts as a price leader, and its market power largely affects the functions of local markets and assembly markets.

1.7.2 Marketing

Major farm products in the project area are paddy, maize, mungbeans and tobacco. Paddy currently produced in the area is mainly non-glutinous variety grown in the rainy season; about 84 percent of non-glutinous rice and about 16 percent of glutinous rice to the total rice production in 1981/1982. Glutinous rice has high palatability in this region. A few products are exported to the other provinces and most of them are consumed within the province. Some high quality rice as Kao Hom is exported to other areas, mainly Bangkok through the hands of rice millers or merchants.

The major crops other than paddy play an important role in farm economy as cash crops because of their high commercial values. Trading of these crops is conducted by quataman and the merchants who are dealing with them in forwarding and selling.

According to the tentative calculation of the rice demand-supply balance at present, the area has a large surplus of rice products in each level as follows:

	Phetchabun Province	Lom Sak District	Phetchabun District	In the Project Area
Population in 1981	798,000	150,000	157,000	55,000
Rice consumption per capita (kg/year)	150	150	150	150
Total consumption of rice per year (tons)	120,000	22,500	23,500	8,300
Rice production in 1981 (tons)	275,000	47,000	72,000	15,500
Surplus (tons)	+155,000	+24,500	+48,500	+7,200

The marketing flows of major crops in the project area are illustrated as shown in Fig. IV-3.

1.7.3 Current Prices of Agricultural Commodities

For the setting of the current prices of agricultural commodities, data and information are collected from commercial office in Phetchabun Province, Agricultural Extension Offices in Phetchabun and Lom Sak Districts and actual farm economy survey together with village survey. From the above data and information, it can be said that the seasonal fluctuation in local market price or farm gate price of farm inputs and farm products is relatively high mainly due to inadequate marketing flow, limited storage facilities, etc. Particularly for paddy, the farmers are often compelled to sell these products to the itinerant buyers immediately after harvesting, resulting in comparatively low selling price. According to farm economy survey, the price of farm products varies from 2.5 baht/kg to 3.2 baht/kg for paddy, from 7 baht/kg to 14 baht/kg for mungbeans, from 25 baht/kg to 35 baht/kg for tobacco. Table IV-8 shows the prevailing farm gate prices of farm products and farm inputs, etc.

1.8 Livestock

Various kinds of livestock are raised in this region. They are buffalo, cattle, swine, goat, sheep, chicken and duck. Table IV-9 shows yearly record of livestock in Phetchabun Province, Lom Sak and Phetchabun District concerned with the project area. For the buffalo and cattle, they are not so playing an important role in land preparation because of many tractors introduced throughout the project area in recent years. The number of various kinds of livestock in both Lom Sak and Phetchabun Districts is gradually decreased as seen in the same table. One of the particulars for raising large livestock in this area is group feeding of buffalo or cattle by some farm households, and many farmers have no keeping of such large livestock at present.

According to farm economy survey together with village survey in the project area, one farm household raises 20 - 25 heads of chicken and duck on an average, which are mainly used for home consumption and to some extent sold in local market.

1.9 Present Typical Farm Budget

The study on the present farm budget is made based on the data and information obtained mainly from the field survey and farm economy survey in the each service area.

Table IV-10 shows the present farm budgets of typical farmers in the respective service areas. In each service area, most of the farmers have upland fields outside the project area, and accordingly the incomes from the upland crops cultivated in these fields are also counted in the farm budget analysis. Income from the livestock is insignificant throughout the project area. The farmers raise mainly chickens and ducks for the home consumption. Miscellaneous income means temporary labor income, selling income of some fruits produced in home yard and other

miscellaneous income. The average annual farm income throughout the project area is still low as compared with that in the whole Thailand.

Recently, the living expenses of farm family have increased due to upgrading of living standard. Surplus or capacity to pay in their budget is rather small in the project area except the Sri Chan and the Pasak Left Bank service areas as seen in Table IV-10.

1.10 Agricultural Constraints

From socio- and agro-economic and agronomic viewpoints, the present major constraints for agricultural development are pointed out as follows:

(1) insufficient and ineffective coordination between respective administrative organizations concerned,

(2) inferior climatic conditions; uneven distribution of rainfall,

(3) high shortage of irrigation water throughout the whole project area due to less irrigation facilities,

(4) lack of effective water management,

(5) lack of modern crop cultivation knowledge and techniques,

(6) insufficient and less proper control of diseases, insects and rats in fields,

(7) insufficient agricultural support services such as agricultural extension services, seed multiplication system and agricultural credits: especially, increase of field extension worker and arrangement of extension equipment, etc. are essential,

(8) lack of farmers' organizations and/or associations, water users' associations and farmers groups for high crop production increase,

(9) inefficiency of marketing system for smooth flow of farm products and farm inputs including the MOF and POW activities,

(10) insufficient transportation facilities for agricultural inputs and outputs, and

(11) scattered-type land holding pattern and small-scale field plot.

2. AGRICULTURAL DEVELOPMENT PLAN

2.1 Basic Concept for Agricultural Development Plan

Following the successful implementation of the Fourth National Economic and Social Development Plan (1977 - 1981), the Government of Thailand has set forth the Fifth National Economic and Social Development Plan for the period from 1982 to 1986.

In the past two decades, the country experienced rapid growth; about 7% of economic growth rate per year in constant price. However, this growth resulted in gross distortions and related problems in the economy. Although agriculture has been responsible for 60% of export income and 75% of national employment, the countryside was neglected and agricultural land became scarce as population grew, and agricultural productivity fell.

The Fifth National Economic and Social Development Plan aims at a more balanced development between the production of industry and agriculture especially in rural areas. Then, the Government has set forth the top priority for the rural development to poverty areas. In this context, the Upper Pasak Medium Scale Irrigation Project was taken up as one of the important agricultural development programs.

The Upper Pasak Medium Scale Irrigation Project, which comprises an irrigation development of about 84,400 rai in net, is formulated to maximize the expected project benefit by means of efficient use of land and water resources. The main concepts of the project are to:

(1) increase and stabilize yield and production of rainy season paddy through supply of irrigation water, proper drainage improvement and introduction of improved irrigation farming as well as improved varieties,

(2) introduce diversified cropping pattern including the rainy season paddy and cash crops such as mungbeans and tobacco through provision of year-round irrigation, and

(3) promote the levelling-up of living standard and more equitable distribution of income of the people.

Because of no notable irrigation and drainage facilities, the existing paddy fields often suffer from long-dry spell even in the rainy season and mal-drainage in depressed lands in the rainy season. Therefore, most of the paddy fields are used only for one cropping a year. Poor road network and insufficient agricultural supporting services are other constraints for the intensive agricultural development in the project area. In order to achieve the projected agricultural development in success, therefore, the construction of following infrastructures and further improvement of supporting services are required:

(1) construction of irrigation network consisting of reservoir and canal system,

(2) construction of drainage network,

(3) construction of road network, and

(4) further improvement of present water management system and agricultural supporting services.

2.2 Proposed Land Use

The net irrigable area of 84,380 rai, which consists of 6,000 rai of the Sri Chan service area, 31,440 rai of the Pasak Left Bank service area, 28,190 rai of the Huai Khon Kaen service area, 11,250 rai of the Huai Yai service area and 7,500 rai of the Khlong Chaliang Lab service area, is selected from the gross area of 113,300 rai. The net irrigable area thus selected will mainly be developed for paddy cultivation in the rainy season and upland crops such as mungbeans and tobacco in the dry season. The remaining non-irrigable area will be used as upland field for the cultivation of vegetables, orchard gardens, village yards, canals, roads, etc. as shown in the following table.

(Unit: Rai)

Land Category	Huai Saduang Yai Sub-project Area			Huai Khon Kaen Sub-project Area			Huai Yai Sub-project Area	Khlong Chaliang Lab Sub-project Area
	Sri Chan Service Area	Pasak Left Bank Service Area	Total	Pasak Left Bank Service Area	Huai Khon Kaen Service Area	Total		
Paddy field	6,000	27,750	33,750	3,690	28,190	31,880	11,250	7,500
Upland field	210	990	1,200	110	870	980	200	150
Orchard	50	250	300	40	340	380	120	40
Village, etc.	700	3,300	4,000	450	4,490	4,940	860	400
Others*	1,030	4,680	5,710	810	5,070	5,880	2,610	1,150
Total	7,990	36,970	44,960	5,100	38,960	44,060	15,040	9,240

* including rivers, canals, roads, wasted lands, forest lands, etc.

2.3 Proposed Cropping Pattern

Paddy is selected as a main crop in the project area. In studying the cropping pattern, the climatic condition, soil characteristics, topography, availability of irrigation water, agronomic characteristics on crops, predominant varieties of crops, availability of labour forces, farmers' desire and national policy for agricultural development are fully taken into consideration.

Fig. IV-4 shows the proposed cropping patterns for the respective sub-project areas which are considered to be the most beneficial for the farmers within the limit of available land and water resources. In this pattern, both glutinous and non-glutinous varieties of rice are proposed. The glutinous variety will be used mainly for home consumption and the non-glutinous rice will be cultivated for export, there will be no over supply of rice in the world market in the foreseeable future especially for the Thai rice, because its international competitiveness is remarkable in quality and price. In order to maximize the potential productivity and profitability of the land and water resources, high yield and tasty varieties of paddy are to be introduced as much as possible.

Cultivation of beans and tobacco will also be introduced into the area after harvesting paddy. Beans are considered to be essential not only for local consumption but also for improvement of soil condition, and tobacco is high-cash crop for export. These crops will largely improve the farm economy.

In order to introduce this proposed cropping pattern into the project area successfully, it is inevitable to provide strong agricultural support services such as agricultural extension services, seed multiplication and its distribution, farmers credits services, cooperatives, water users' associations, farmers training and good transportation networks.

The sowing or transplanting periods and harvesting periods of the proposed crops are as shown in the following table:

Crops	Nursery Period (days)	Growing Period on Paddy Field (days)	Transplanting or Sowing Period	Harvesting Period
Rainy season paddy (L.V)	25 - 30	120	Big. of July - End of Aug.	Big. of Nov. - End of Dec.
(H.Y.V)	20 - 25	105	Big. of June - End of July	Mid. of Sept. - Mid. of Nov.
Beans	-	70 - 80	Big. of Nov. - End of Nov.	Mid. of Feb. - End of Feb.
Tobacco	30 - 40	4 - 5 (months)	Mid. of Oct. - Big. of Nov.	Mid. of Mar. - Mid. of Apr.

2.4 Proposed Farming Practices

2.4.1 General

Together with the introduction of modernized irrigation and drainage systems, the improved farming practices will be introduced into the area to maintain the high crop productivity. These are use of high yield variety, proper fertilizer application, pest and disease control, agro-mechanization, proper management of irrigation water, etc.

2.4.2 Paddy Cultivation

Varieties of paddy being cultivated in the project area at present are RD-1, RD-7, RD-15 of non-glutinous type and RD-2, RD-6 of glutinous type, all of which are high yield varieties, Hom Ma Li 105, Lueng Yai 148 of non-glutinous type and San Pah-Tawng, Kao Hom of glutinous type, all of which are local varieties. These are mainly cultivated under rain-fed conditions at present except in the Sri Chan and the Pasak Left Bank service areas, with a little or without agricultural inputs such as fertilizers and agro-chemicals. Thus, the yield of paddy in the project area is comparatively low.

For the increase of yields, distribution of good quality seeds of high yielding varieties is essential. In this context, the RD varieties such as RD-21, RD-23 and RD-25 of non-glutinous type and RD-4 and RD-10 of glutinous type, all of which are high yield varieties, Lueng Yai 148, Khao Dawk Mali 105, Ham Ma Li 105 of non-glutinous type and Niaw San-Pha-Tawng, Mei-nang 62M, Niew San Datong of glutinous type, all of which are improved local varieties, are recommended in the project area from the view points of physiology and productivity (Table IV-14).

Table IV-11 shows the standard cultivation method of irrigated paddy. The amount of seed needed is about 5 kg per rai of paddy field. The required amount of fertilizer for nursery bed (6 - 7% of main field) for per rai of main field is about 100 g of urea and 50 g of Triple Super Phosphate, respectively. Prior to the seeding, the seed should be selected by a solution of 1.13 specific gravity, and further be treated by using agro-chemicals such as Benlate-T or Homai to control the diseases.

Land preparation for transplanting will be started about a half month before the transplanting in general. The recommended number of seedling per hill is 3 to 4, and the optimum planting density is about 20 hills per m^2 for high yield varieties an 15 hills per m^2 for local varieties.

With regard to the basal fertilizer application for paddy, it is better to apply fertilizers of about 20 kg of mixed fertilizer per rai at the time of about 5 days before transplanting. Top dressing with fertilizer will be carried out 2 to 3 times; at the time of about 15 days after transplanting, at the initial young panicle formation stage, and further at the full heading stage, if needed. The amount of fertilizer

to be applied per rai is about 15 kg of urea for each dressing time in case of the high yield varieties.

Insect and disease control for paddy cultivation has to be carried out at the proper time without delay. Recommendable agro-chemicals are Sumithion, Diazinon, etc. for insect control and Kasumin, Kitazin, etc. for disease control. The rat damage is considerably serious in the project area. It is better to apply rodenticides like zink-phosphate at the rate of about 40 g per rai.

Weed control in the paddy field is to be carried out about 2 or 3 times according to the condition of the weed growth. The proposed practice for weeding is to use the rotary weeder. For the weed control in future, harbicides may be applied, and careful consideration should be given for their apply, because various kinds of effective harbicides have been developed recently.

Proper water management is very essential on paddy cultivation. There are critical periods in the life of the rice plant against the lack of water, i.e. just after sowing or transplanting time, panicle initiation stage, reduction division stage, flowering stage, etc. Proper irrigation management is to be introduced according to the growth stage.

Harvesting paddy by sickle has been introduced for the high yielding varieties of paddy which are commonly of short straw. After cutting paddy, the paddy harvested laid down on the field for 2 - 3 days to dry. The stalked paddy thus dried is spread over the threshing floor which is prepared in advance at the elevated land and threshed manually or by cattle or buffalo tramping over them. Pedal threshers are being introduced to the project area. For the high yield varieties, however, the mechanical threshing by means of engine-driven harvester and treadle thresher is recommendable.

2.4.3 Other Major Crops

Other major crops such as mungbeans and tobacco will mainly be cultivated in every sub-project area after harvesting the rainy season paddy.

The standard cultivation methods of these crops are shown in Table IV-12 and IV-13 respectively. Modern cultivation techniques such as introduction of high yield varieties, reasonable fertilizer application method and control of insects and diseases should be introduced into the area after completion of the project. In order to attain the expected high yield of these crops, it is inevitable to provide not only the above various modern cultivation techniques but also strengthening of the present agricultural support services.

2.5 Anticipated Crop Yield and Production

2.5.1 Anticipated Crop Yield

The anticipated crop yield is estimated on the basis of the data and information obtained from the Provincial and Districts Agricultural Extension Offices, village survey, farm economy survey in the project area and with reference to the results of crop experiment of some experimental stations in Thailand.

Table IV-15 shows the paddy yield of RD-1 variety at Bankhen Experimental Station in 1969. The yields of RD-1, IR-5 and IR-8 varieties are over 1,000 kg/rai in all cases, and it can be said that these varieties have a high productivity, and furthermore these varieties have a good response to fertilizer application as seen in Table IV-16.

Table IV-17 shows the some observed high records of paddy yield in each region for past 4 years. In this table, it is observed that the yield of paddy is very high; over 1,000 kg/rai in each region.

According to the results in a large demonstration farm in Northern region in 1966, about 850 kg/rai of maximum average yield of fertilized farm and about 470 kg/rai of average yield of non-fertilized farm are reported.

According to the Agricultural Office in Phetchabun Province, high records of paddy yield in demonstration farms operated by farmers range from 1,000 kg/rai to 1,500 kg/rai of high yield varieties and from 700 kg/rai to 900 kg/rai of local varieties in 1981.

Judging from the above various data and information, about 80% of the high-recorded yields; 640 kg/rai (4.0 tons/ha) for local variety and 800 kg/rai (5.0 tons/ha) for high yield variety can conservatively be expected under the proper irrigated conditions with proper farming practices.

As for the upland crops such as mungbeans and tobacco, the target yields are estimated to be 240 kg/rai (1.5 tons/ha) of mungbeans and 400 kg/rai (2.5 tons/ha) of tobacco under "with project" condition.

On the other hand, the yields of crops under "without project" condition are deemed to be the same as those of "present" condition for all the crops owing to unstable rainfall distribution even in the rainy season, high variance of crop yield from year to year and stagnant crop yield since 1970 in the Phetchabun Province.

2.5.2 Build-up Period of Target Yield

Discussion is made for the study on build-up period of attaining the final target of the proposed agricultural development. In this study, the following conditions are taken into consideration:

(1) development of O & M techniques of irrigation and drainage facilities under the project,

(2) improvement of the infrastructures in connection with the project,

(3) further improvement of agricultural support services such as effective activities of field extension worker, good seed multiplication and its distribution, adequate farmers' credits service, proper water management, etc.

(4) raising-up of farmers' techniques trained under the rural agricultural extension service,

(5) increasing of soil fertility and stabilization of land condition in future after the reclamation of the project area.

Although the farmers in the project area are familiar with paddy cultivation, most of them are not so skilled for improved farming practices like fertilization, plant protection, water management, etc. under irrigated condition, and it would take time to train them in these fields particularly for managing the irrigated farming.

After implementation of the project, the yield of crops would increase year after year with proper water management, adequate farm inputs supply and sufficient agricultural support services. Throughout the project area, the farmers are rather accustomed to intensive farming, the crop yield would reach the expected yield about 5 years after commencement of the irrigation water supply.

Table IV-18 shows the estimated yield of crops during those build-up period.

2.5.3 Anticipated Crop Production

The yield and production of crops in the project area will increase year by year under the proper irrigation farming and drainage improvement as well as strengthening of the agricultural support services, etc. Based on the proposed cropping pattern, irrigation area and target yields of the crops, the total crop production in "with project" and "without project" in each development area is estimated as shown in Table IV-19. The increase of each crop production after implementation of the project works is estimated as shown in Table IV-20. The annual paddy production at the full development stage in the project area would be about 63,500 tons of dry paddy and the incremental production would be about 39,600 tons in total.

2.6 Market and Price Prospects

2.6.1 Marketing Prospects of Crops

Rice is the most important crop not only as the main food for Thai people but also as the main source of foreign exchange earning at present. In the Phetchabun Province, about ฿1,713 x 10^6 or 25.3% of the total agricultural production value could get from rice in 1981 according to the Summary Report in 1982. In the project area, rice is also the main food item and staple food and major income source for all farmers as described in the previous chapter. Farmers in the project area desire to get high rice production increase under well irrigated condition according to villages survey and farm economy survey.

In 1990, when the full development of the project is attained, the demand-supply balance of rice at each level would be as follows:

	Phetchabun Province	Lom Sak District	Phetchabun District	Project Area
Population in 1981	798,000	150,000	157,000	55,000
Population growth rate (%)	3.70	2.61	2.71	2.66
Population estimated in 1990	1,106,000	189,000	200,000	70,000
Rice consumption per capita (kg/year)	150	150	150	150
Total consumption of rice in 1990 (tons)	166,000	28,400	30,000	10,500
Rice production in 1981	275,000	47,000	72,000	15,500
Increase of rice production by project implementation	25,900	20,400	5,500	25,800
Total rice production in 1990	300,900	67,400	77,500	41,300
Surplus (tons)	+134,900	+39,000	+47,500	+30,800

As seen in the above table, surplus for rice at each level will be significant and would be exported to outside of the provinces or Bangkok market. Especially in the project area, the rice production will increase by 25,800 tons from about 15,500 tons of rice at present.

The production of mungbeans in the project area is about 1,000 tons at present. About a half of mungbeans produced in the project area is used for home consumption and remainings of mungbeans are directly sold to local market or Bangkok through local merchants. After completion of

the project works, about 3,000 tons of mungbeans are expected to be produced in the project area, and most of mungbeans would be marketed to Bangkok or exported abroad.

As for the tobacco, about 1,600 tons are produced at present in the project area and most of tobacco produced are sold to Tobacco Monopoly Office or local merchant except a few home consumption. In some villages in the project area, the purchase price of tobacco by private tobacco company or brokers is high for about 4 - 5 baht/kg as compared with that of Tobacco Monopoly Office, so tobacco is predominantly sold to the private tobacco companies or brokers. After implementation of the project, about 6,700 tons of tobacco will be produced in the project area, and most of tobacco will be marketed not only for domestic consumption in Thailand but also for export to abroad. One of the conditions needed for marketing tobacco in future is to improve present market channel like existing tobacco broker. The normal marketing flow to tobacco should not be through tobacco brokers but through Tobacco Monopoly Office under close cooperation of MOF and other authorities concerned.

2.6.2 Price Prospects

(1) Rice/Paddy

Economic Prices: Economic price of rice/paddy at farm gate is estimated on the basis of the projected international market price forecasted by IBRD for the period of 1990 in 1982 converted constant dollars and further taking into account the costs for transportation, processing and others. Table IV-21 shows the rice/paddy price at the farm gate estimated for economic evaluation of the project (Table IV-22).

Financial Prices: Financial price of rice/paddy at farm gate are estimated based upon available data on the farm gate price collected through farm economy survey and prevailing local market prices in Phetchabun and Lom Sak Districts. The estimated financial price of rice/paddy is given in Table IV-21.

(2) Other Crops

Economic prices of mungbeans and tobacco at farm gate are estimated on the basis of the projected international market prices forecasted by IBRD as shown in Table IV-21. Financial prices of the above products at farm gate are estimated based upon the data and information collected from commercial office in Phetchabun Province, Agricultural Extension Offices, farm economy survey, etc., and also shown in Table IV-21 (Tables IV-22 and IV-23).

(3) Farm Inputs

Economic prices of farm inputs at farm gate are estimated based on the projected international market prices forecasted by IBRD.

On the other hand their financial prices at farm gate are estimated on the basis of the farm economy survey carried out in 1982 and referring to the local market prices in Phetchabun and Lom Sak town. Table IV-21 shows the economic and financial prices of major farm inputs respectively (Table IV-24).

2.7 Crop Production Cost

2.7.1 Farm Inputs

Among the items constituting the crop production costs, direct farm inputs such as seed, fertilizer, agro-chemical and labour force are the foundamental ones. Data and information on the farm inputs were mainly collected from the agricultural extension offices and through farm economy survey carried out in villages concerned with the project area.

After implementation of the project, the farm inputs will increase substantially. Table IV-25 shows the amount of farm inputs estimated for each crop in "with project" condition. These requirements are estimated based on the experimental data available, input requirement recommended by Provincial Agricultural Extension Service Office, Branch of Economy and Irrigated Agriculture Section, RID. The quantity of fertilizers and agro-chemical needed will also remarkably increase. As for the farm inputs under "without project" condition, it is considered that the farming conditions will not much change from the present ones, and accordingly, the amount of farm input in case of "without project" is taken to be the same as that of the "present condition" in the estimate of the project benefit.

2.7.2 Labour Requirement

Family labour will mainly be used for farming throughout the year. Some temporary labour will be employed during the period of transplanting and harvesting of paddy and harvesting of tobacco at present. The proposed farming will be practiced basically by family labour with some agro-machinery such as hand tractor, sprayer, thresher and other farming equipment and tools.

Table IV-26 shows the labour requirement per rai for the proposed irrigation farming, and Table IV-27 shows the monthly labour requirements for crop cultivation per family. According to Table IV-27, the family labour can cover the labour requirements throughout the year.

2.8 Net Incremental Benefit

Net incremental benefit of the project is defined as the difference between the net production value with the project and the net production value without the project. The net production value is defined as the difference between the gross production value and the production cost.

Table IV-28 shows the production cost estimated for the anticipated crops in both "with project" and "without project" conditions. The estimate of the production cost is made on the basis of the required quantities of farm inputs and their prices. Table IV-29 and Table IV-30 show the gross and net production values at the full development stage in both "with project" and "without project" conditions in each sub-area. Table IV-31 shows the incremental benefit of the project. The benefit from the paddy and tobacco cultivation is predominant in most of the development area. The following table shows the summary of net incremental benefit of the project at the full development stage.

Area	With Project (฿10^3)	Without Project (฿10^3)	Net Incremental (฿10^3)	Net Incremental (US$10^3)
Huai Saduang Yai Sub-Project Area	248,274	113,609	134,665	5,855
Huai Khon Kaen Sub-Project Area	234,933	71,556	163,377	7,103
Huai Yai Sub-Project Area	82,799	23,874	58,925	2,562
Khlong Chaliang Lab Sub-Project Area	55,157	18,235	36,922	1,605
Whole Area	621,163	227,274	393,889	17,125

2.9 Typical Farm Budget

From the farmers' viewpoint, the financial evaluation in "with project" and "without project" conditions was made for typical farm household in each sub-area. Calculation for both income and outgo was made based on the production and estimated prices of farm products and inputs.

In every case, the income from paddy and tobacco cultivation is predominantly increased in "with project" condition. In each sub-project area, the income from livestock is insignificant. The gross income in each sub-project area will increase remarkably after completion of the project as compared with its income in "without project" condition owing to the level-up of crop cultivation techniques under sufficient irrigation condition with effective agricultural support services, etc.

The expenditures for crop production in "with project" condition would increase substantially due to application of certain amount of fertilizers and agro-chemicals, and family living expenses would also increase as compared with those in "without project" condition.

The following table shows the comparison of income, outgo and balance (or capacity to pay) in "with project" and "without project" conditions in each sub-area. Details are shown in Table IV-32 and Table IV-33.

Description	Huai Saduang Yai Sub-Project Area		Huai Khon Kaen Sub-Project Area		Huai Yai Sub-Project Area		Khlong Chaliang Lab Sub-Project Area	
	With Project	Without/ Present Project	With Project	Without/ Present Project	With Project	Without/ Present Project	With Project	Without/ Present Project
1. Gross income (฿)	56,578	35,694	57,940	32,404	59,313	29,326	57,168	29,970
2. Farm outgo (฿)	48,830	34,908	49,902	32,357	49,527	29,273	49,044	29,921
3. Balance or capacity to pay (฿)	7,749	786	8,038	47	9,786	53	8,124	49
(US$)	337	34	349	2.0	425	2.3	353	2.1

POPULATION, POPULATION DENSITY AND GROWTH RATE

(1) Population

(Unit: 10^3 persons)

Year	Phetchabun Province	Districts	
		Lom Sak	Phetchabun
1970	536	113	117
1971	566	116	122
1972	608	119	125
1973	632	123	133
1974	657	127	139
1975	680	130	142
1976	716	134	144
1977	734	139	147
1978	754	145	148
1979	767	146	151
1980	785	147	153
1981	798	150	157

Source: - Statistical Reports of Phetchabun, 1980, National Statistical Office

- Section of Statistic, Phetchabun Province, 1982

(2) Population Density and Growth Rate in 1981

	Area (km^2)	Density (person/km^2)	Growth Rate (%)
Phetchabun Province	12,679	62.9	3.70
Lom Sak District	1,690	88.8	2.61
Phetchabun District	3,091	50.8	2.72

Source: - Statistical Reports of Phetchabun, 1980, National Statistical Office

- Section of Statistic, Phetchabun Province, 1982

PRESENT LAND USE IN THE PROJECT AREA

(Unit: rai)

	Sri Chan Service Area	Pasak Left Bank Service Area	Huai Khon Kaen Service Area	Huai Yai Service Area	Khlong Chaliang Lab Service Area	Total Area
Paddy field	4,980	26,080	19,950	10,910	7,340	69,260
Upland field	1,230	6,460	9,110	540	310	17,650
Orchard	70	390	420	150	60	1,090
Village, etc.	880	4,640	5,310	1,210	640	12,680
Others/1	830	4,500	4,170	2,230	890	12,620
Total	7,990	42,070	38,960	15,040	9,240	113,300

Source: - Agricultural Offices in Phetchabun and Lom Sak Districts, 1982
- Village Survey, 1982
- Farm Economy Survey, 1982

Note : /1: Including rivers, canals, roads, wasted land, forest land, etc.

CROP INTENSITY IN WET SEASON AND DRY SEASON IN THE PASAK RIVER LEFT BANK PROJECT

Year	Rainy Season (%)	Dry Season (%)	Total (%)
1970/71	100.0	21.8	121.8
1971/72	100.0	15.6	115.6
1972/73	100.0	6.5	106.5
1973/74	93.8	7.8	101.6
1974/75	100.0	11.8	111.8
1975/76	100.0	12.8	112.8
1976/77	100.0	21.8	121.8
1977/78	98.1	22.8	120.9
1978/79	87.5	43.7	131.2
1979/80	92.2	15.6	107.8
1980/81	100.0	43.4	143.4
Average	97.4	20.3	117.7

Source: - Pasak River Left Bank Project Office, 1982
Total irrigable area : 32,000 rai
Dry Season Crops are mainly introduced Mungbean & Tobacco in the project area.

PRESENT FARM INPUTS AND LABOR REQUIREMENTS

		Rainy Season Paddy (L.V)	Rainy Season Paddy (H.Y.V)	Mung-beans	Tobacco	Maize
(1)	Farm Inputs					
	Seed (kg/rai)	5.0	6.0	5.0	3,500/1	3.0
	Fertilizer					
	Urea (kg/rai)	-	-	-	-	-
	Mixed fertilizer (kg/rai)	-	-	-	100	-
	Agro-chemicals					
	Insecticides (lit/rai)	0.1	0.1	0.5	1.0	0.1
	Fungicides	-	-	-	-	-
	Rodenticides	-	-	-	-	-
(2)	Labor Requirements				(Unit: men/days)	
	Nursery	0.07	0.07	-	0.33	-
	Land preparation/2					
	Plowing	0.49	0.49	0.07	0.12	0.37
	Harrowing	0.52	0.52	0.08	0.15	0.01
	Paddling	-	-	-	0.32	-
	Transplanting or sowing	2.66	3.18	0.18	5.22	1.38
	Weeding	0.85	1.03	-	1.46	1.36
	Fertilizing	-	-	-	3.65	-
	Spraying	0.10	0.13	0.30	2.47	0.19
	Harvesting	3.31	4.00	2.76	10.50	2.15
	Threshing	1.91	2.11	0.24	6.89	0.30
	Others	-	-	-	-	-
	Total	9.91	11.53	3.63	31.11	5.77

Source: - Farm Economy Survey, 1982
- Provincial Agricultural Office, 1982
- Branch of Economy Section, RID, 1981

Note : /1; Number of seeding
/2; With use of tractor

MAJOR CROP CULTIVATION METHOD AT PRESENT

	Paddy	Mungbeans	Maize	Tobacco
Varieties	- Glutinous varieties: San Pha Tawng, Kao Hom*, Sang Lueng, Hom Pama, E-Dang, RD-2, RD-6 - Non-glutinous varieties: Hom Ma Li 105*, Lueng Yai, Kao Ruang, Nang Mon, Kao Ta Haeng, RD-1, RD-7*, RD-15	Native variety, U-tong No.1*	Suwan 1*, Suwan 2*, Praputhaphat 5, Guatemala	Burkley*, Virginia
Sowing Period	June - July	January - February	March - April	November - December
Nursery Bed	5 - 7% of the paddy field	—	—	About 4 m^2/rai
Amount of Seed	6 - 7 kg/rai	5 kg/rai	4 - 5 kg/rai	1 Table spoon/rai
Period of Nursery	1 - 1.5 months	—	—	1.5 months
Period of Transplanting	July - August, by hand	—	—	Beg. of January - February
Density of Transplanting or Sowing	20-30cm x 30-35cm, 4-5 trees/hill (13.3 - 9.5 hill/m^2)	5 - 15cm (about 10cm)	50-60cm x 60-70cm	60cm x 90cm or 3,500 trees/rai
Depth of Planting or Sowing	3 - 7 cm	—	5 - 7 cm	—
Fertilizer Application	No fertilizer	No fertilizer	No fertilizer	Mixed fertilizer: 100 kg/rai
Weeding	About 2 times, by hand	No weeding	No weeding or 1 time by hand	2 - 3 times, by hand
Spraying	1 time	2 - 3 times (Folidole, Pivate, etc. Mainly insecticides are sprayed.)	No spraying or 1 time	3 - 4 times (Rannate, Hemovit, Kotophose, Thiodan)
Harvesting	November - December Rice harvest is commonly used sickle. Yield; 180 - 700 kg/rai	1 - 2 times Yield; 100 - 130 kg/rai	100-200 days after sowing, by hand Yield; 380-450 kg/rai	4 - 5 times, by hand Yield; 300 kg/rai as curing leaves
Threshing	Mainly manual or cattle	by manual or threshing machine	Mainly threshing machine	—
Drying	3 days in sunlight after harvest and before threshing in general	—	—	1st curing of tobacco leaves after harvest is carried out at a shed into home yard in general.
Bagging	Hauling to storage barn	—	—	—
Selling	Rice Mill Owner come to buy at village.	Marchant from Lom Sak and Phetchabun Districts or broker	Merchant from Lom Sak and Phetchabun Districts or broker	Tobacco Monopoly Office or Tobacco Company**

* Predominant Variety or High Yield Variety

** Selling in some village ; 80% sell to Tobacco Company and 20% sell to Tobacco Monopoly Office.
Price of Tobacco by Tobacco Company is about 4 - 5 baht/kg higher than that of Tobacco Monopoly Office in general.

Source: - Farm Economy Survey and Village Survey, 1982

RATE OF CROP DAMAGE IN PHETCHABUN PROVINCE, PHETCHABUN AND LOM SAK DISTRICTS

(Unit: %)

Crops	Phetchabun Province					
	1976	1977	1978	1979	1980	1981
Paddy; Glutinous				15.8	30.9	3.4
Non-glutinous				25.8	10.0	4.5
Weighted average	6.7	16.3	22.0	24.3	13.8	4.3
Mungbeans	1.0	7.6	0	25.4	3.9	6.6
Maize	7.0	5.0	-	1.5	10.2	1.0
Soybeans	2.3	1.0	2.0	11.4	23.2	11.0
Tobacco	0	0	81.9	1.0	0	0

Crops	Phetchabun District					
	1976	1977	1978	1979	1980	1981
Paddy; Glutinous				0	0	9.5
Non-glutinous				5.5	34.1	8.6
Weighted average	0	0	27.0	4.6	28.7	14.0
Mungbeans	0	0	0	23.2	6.2	0
Maize	1.7	5.4	0	5.3	26.1	0
Soybeans	0	0	0	0	0	0
Tobacco	0	0	0	-	0	0

Crops	Lom Sak District					
	1976	1977	1978	1979	1980	1981
Paddy; Glutinous				0	11.0	5.9
Non-glutinous				0	12.4	7.1
Weighted average	2.1	24.2	7.5	0	11.9	6.6
Mungbeans	0	0	-	0	0	0
Maize	5.2	2.0	-	3.3	1.0	0
Soybeans	0	65.7	-	0	-	-
Tobacco	0	0	-	0	0	0

Source: - Phtechabun Agricultural Extension Office, 1982

TABLE IV-7

CROPPED AREA AND PRODUCTION

Major Crops	Sri Chan Service Area		Pasak Left Bank Service Area		Huai Khon Kaen Service Area		Huai Yai Service Area		Khlong Chaliang Lab Service Area	
	Area (rai)	Production (tons)	Area (rai)	Production (tons)	Area (rai)	Production (tons)	Area (rai)	Production (tons)	Area (rai)	Production (tons)
Rainy Season paddy (L.V)	1,240	620	6,490	3,250	5,760	2,530	5,290	2,330	3,600	1,580
Rainy season paddy (H.Y.V)	2,070	1,350	10,820	7,040	5,760	3,170	2,120	1,170	1,440	790
Total	3,310	1,970	17,310	10,290	11,250	5,700	7,410	3,500	5,040	2,370
Mungbeans	830	100	4,330	520	1,440	170	850	100	720	90
Tobacco	620	170	3,260	880	1,440	390	210	60	360	100
Maize	1,020	430	5,360	2,260	8,240	3,460	340	140	160	70

Note: Cropped area is estimated based on the land use survey and the data provided by sub-districts offices concerned.

FARM GATE PRICES AT PRESENT

	Item	Unit Price (Baht/kg, lit. or head)	Remarks
Farm Products,	Rice	5.3	
	Paddy	2.8	Dry paddy
	Maize	2.4	
	Mungbeans	8.5	
	Soybeans	7.0	
	Peanuts	6.4	
	Tobacco	28.0	
Seed,	Paddy	4.0	
	Maize	6.0	
	Mungbeans	10.0	
	Soybeans	9.0	
Seedling,	Tobacco	35.0	1,000 trees
Fertilizer,	Urea	6.0	
	Mixed fertilizer	8.0	
Agro-chemical,	Insecticides	180.0	1 liter
	Fungicides	150.0	1 liter
	Rodenticides	2.0	100 g
Livestock,	Cattle	6,500	
	Buffalo	10,000	
	Swine	1,700	
	Chicken	37	
	Duck	40	
	Egg (chicken)	1	1 piece
Agro-equipment,	Hand tractor	30,000	
	Sickle	20	
Labor,	Light	30	1 person/day
	Heavy	40	1 person/day
	Land preparation by tractor	150	per rai

Source: - Farm Economy Survey together with village survey, 1982

- Commercial Office in Phetchabun Province, 1982

- Agricultural Office in Phetchabun and Lom Sak District, 1982

YEARLY RECORD OF LIVESTOCK

(Unit: head)

	Year	Buffalo	Cattle	Swine	Goat	Sheep	Chicken and Duck
Phetchabun Province	1975	110,880	85,090	42,380	330	600	671,840
	1980	119,860	114,520	71,010	-	-	516,870
	Ratio (1980/1975)	1.08	1.35	1.68	-	-	0.77
Lom Sak District	1975	15,780	29,010	11,220	-	-	176,170
	1980	8,790	12,820	4,550	-	-	16,500
	Ratio (1980/1975)	0.56	0.44	0.41	-	-	0.09
Phetchabun District	1975	18,310	27,650	8,860	60	10	171,400
	1980	15,610	24,680	8,750	-	-	149,290
	Ratio (1980/1975)	0.85	0.89	0.99	-	-	0.87
Total Districts	1975	34,090	56,660	20,080	60	10	347,570
	1980	24,400	37,500	13,300	-	-	165,790
	Ratio (1980/1975)	0.72	0.66	0.66	-	-	0.48

Source: - Agricultural Statistics of Thailand, Crop Year 1979/1980, Ministry of Agriculture & Cooperatives, 1980

- Department of Livestock, 1982

PRESENT TYPICAL FARM BUDGET

(Unit: baht)

Sub-Area	Sri Chan and Pasak Left Bank Service Areas	Huai Khon Kaen Service Area	Huai Yai Service Area	Khlong Chaliang Lab Service Area
Family size	5.5 persons	6.5 persons	5.5 persons	5.5 persons
Farm size;				
Paddy field	7.3 rai	6.5 rai	9.8 rai	9.1 rai
Upland field/1	15.8 rai	15.6 rai	9.7 rai	11.6 rai
1. Gross Income				
Farm income	33,524	27,405	20,860	24,244
Paddy (L.V)	2,457	2,233	5,643	5,299
(H.Y.V)	5,515	2,895	2,926	2,741
Beans	1,234	479	775	908
Tobacco	6,880	3,553	1,436	3,402
Upland crops	17,438	18,245	10,080	11,894
Livestock income	1,280	1,899	1,566	1,626
Miscellaneous income	890	3,100	6,900	4,100
Total	35,694	32,404	29,326	29,970
2. Outgo				
Farm expenses	6,340	5,237	4,086	4,787
Paddy (L.V)	475	491	1,239	1,164
(H.Y.V)	906	562	568	532
Beans	221	86	139	163
Tobacco	1,622	838	339	803
Upland crops	3,116	3,260	1,801	2,125
Livestock expenses	128	190	157	164
Tax, etc.	140	130	180	200
Family living expenses	28,300	26,800	24,850	24,770
Total	34,908	32,357	29,273	29,921
3. Balance or Capacity to Pay	786	47	53	49
(US$)	34.2	2.0	2.3	2.1

Note: /1; including the areas which the farmers possess outside the project area.

STANDARD CULTIVATION METHOD OF IRRIGATED PADDY (H.Y.V)

Days	Management	Amount of Implementation
	(Preparation of Nursery)	
- 3	Seed selection	Salt solution for seed selection 10 liters of water + 2 kg of NaCl
- 3	Seed disinfection	Benlate-T/1 (200-400 times, 6-12 hours) or Homai (200-400 times, 6-12 hours)
- 2	Seed soaking	36 hours
- 2	Hastening of germination	24 hours
- 1	Application of fertilizer	Urea 100 g, Triple Super Phosphate 50 g per rai
0	Sowing	Acreage 100 m^2/rai, Seed 5 kg/100 m^2
15	Control of disease and insect damage	Diazinon 30-50 cc in 1,000 liters of water 100 lit./100 m^2 spraying, about 2 times
	Nursery Period: 20 - 25 days	
	(After transplanting)	
	(Preparation of Paddy Field)	
- 5	Basal manuring	Mixed fertilizer 20 kg/rai
0	Transplanting	Spacing 20 x 25 cm (20 hills per m^2) 3-4 seedling per hill, 25 days-aged seedling.
10	Weeding (1st)	Hand rotary weeding
13	Control of disease and insect damage (1st)	Diazinon 0.14 lit./rai, Kasumin 0.1 lit./rai
15	Application of fertilizer (Top dressing)	Urea 7 kg/rai
30	Weeding (2nd)	Hand rotary weeder
40	Control of disease and insect damage (2nd)	Sumithion 0.13 lit./rai, Kasumin 0.1 lit./rai
60	(Panicle initiation period)	
63	Application of fertilizer (2nd)	Urea 8 kg/rai
70	(Booting period)	
73	Control disease and insect damage (3rd)	Diazinon 0.13 lit./rai
80	(Heading period)	
105-110	Harvesting	Use of sickle

Note: /1; for paddy seedling diseases, rice blast, rice leaf spot, etc.

STANDARD CULTIVATION METHOD OF MUNGBEANS

Days	Management	Amount of Implementation
	(Preparation of field)	
0	Sowing	Seed 6 kg/rai Spacing 25 x 25 cm or row 50 cm and hole 20 cm with dig 4-5 seeds/per hole number of mungbeans 32,000 stem/rai
17	Application of fertilizer (1st)	Mixed fertilizer 6 kg/rai
20	Intertillage and weeding	Hoe and hand
30	Control insect damage (1st)	Spraying of Sumithion 0.15 lit./rai
45	Application of fertilizer (2nd)	Mixed fertilizer 4 kg/rai
47	Intertillage and weeding (2nd)	Hoe and hand
50	Control insect and disease damage (2nd)	Spraying of Sumithion 0.15 lit./rai and 0.1 lit./rai of fungicide
80	Harvesting Drying	By hand, about 2 times 2-3 times

Note: Recommendable high yield variety; U-Tong I

STANDARD CULTIVATION METHOD OF TOBACCO

Days	Management	Amount of Implementation
	(Preparation of Nursery)	
-2	Application of fertilizer	NPK fertilizer 1 kg/5 x 1 m^2
-2	Control of insect damage	Furodal 150 g /5 x 1 m^2
0	Sowing	Seed mixed ash, 1 g/ 5 x 1 m^2
7	Water management (Pour on bed)	3 times a day before seedling
30	Water management (Pour on bed)	2 times a day after seedling
35	Water management (Pour on bed)	1 time a day only a little
40	Water management (Pour on bed)	1 time a day heavy
40	Control of insect and diseases	Asodrin and Lannate
	Nursery Period : about 40 days (After transplanting)	
	(Preparation of tobacco planting field)	
-5	Basal manuring	Mixed fertilizer 100 kg/rai
0	Transplanting	Mid. of Oct. - Mid. of Nov. Spacing- 50-60 ^{cm} x 100 ^{cm} or 3,500 trees/rai
20	Application of fertilizer	Urea 30 kg/rai
25	Weeding	By hand or harbicide
30	Control of insect and disease	Spraying of Diazinon 0.3 lit./rai and 0.15 lit./rai of Captan
40	Application of fertilizer	Mixed fertilizer 50 kg/rai
50	Weeding	By hand or harbicide
	Control of insect and disease	Spraying of Sumithion 0.4 lit./rai and 0.15 lit./rai of Captan
	Harvest begins	About 5-6 times
65	Application of fertilizer	Urea 20 kg/rai
70	Picking Out tobacco flower	By hand
75	Weeding	By hand or harbicide
	Control of insect and disease	Spraying of Diazinon 0.3 lit/rai and 0.2 lit./rai of captan
100	Harvest finish	

Source : - Factory of Tobacco, Bangkok, 1982
- Tobacco Monopoly Office in Phetchabun Province, 1982

TABLE IV-14

TABLE IV-15

RECOMMENDABLE VARIETIES OF PADDY

	Varieties	Growing Period (days)	Yield Average (kg/rai)	Yield Maximum (kg/rai)	Remarks
High yield	RD- 4	125-130	638	906	Glutinous
Varieties	RD-10	130	700	800	Glutinous
	RD-11	130-140	698	753	Non-glutinous
	RD-21	120-130	800	1,000	Non-glutinous
	RD-23	120-130	800	1,000	Non-glutinous
	RD-25	100	700	800	Non-glutinous
Improved local	Lueng Yai 148	120-130	500	600	Non-glutinous
Varieties	Khao Dawk MaLi 105	150	543	623	Non-glutinous
	Niaw San-Pah-Tawng	120-130	570	600	Glutinous

Source : Rice Division, Department of Agriculture, Ministry of Agriculture and Cooperatives, 1982.

PADDY YIELD OF RD-I AT BANGKHEN EXPERIMENTAL STATION IN 1969

Rice Varieties	Yield (kg/rai)	Yield (Ton/ha)	Growing Period (days)
RD-1	1,160	7.2	120-130
IR-5	1,118	7.0	
IR-8	1,021	6.4	
Lueng Tawng	504	3.2	

Source : - Rice Cultivation in East-North Asia,
- Tropical Agricultural Research Center, Japan
Dr. N. Yamada

YIELD OF RICE CULTIVATED IN DIFFERENT SOIL SERIES IN FARMERS' FIELDS (RAINY SEASON PADDY)

Province	Soil Series	Varieties	High Yield		Profit	
			Rate of fertilizer (kgN/rai)	Yield (kg/rai)	Rate of fertilizer (kgN/rai)	Yield (kg/rai)
Singburi	Chainat	RD- 7	27	800	19	781
		RD-11	32	965	25	949
		Lueng-Pra-tiew 123	12	720	3	698
Chainat	Saraburi	RD- 7	28	802	17	773
		RD-11	19	838	13	823
		Lueng-Pra-tiew 123	11	656	6	644
Supanburi	Nakornpatom	RD-7	25	734	17	716
		RD-11	22	745	16	731
		Lueng-Pra-tiew 123	11	649	8	642
	Dermbang	RD- 5	19	726	14	713
		RD- 7	23	774	16	759
		Lueng-Pra-tiew 123	15	575	9	562
Phachinburi	Mahapoch	RD-11	28	759	24	749
		RD-19	12	669	11	665
		Lueng-Pra-tiew 123	8	581	6	577
Khon Kaen	Pimai	Niaw San-Pah-Tawng	11	649	8	642
Nakonrachasima	Pimai	RD-7	27	754	23	744
		RD-15	16	562	14	558

Source : -Report of Rice Research, Rice division, Ministry of Agriculture and Cooperatives, 1979.

TABLE IV-16

OBSERVED HIGH RECORDS OF PADDY YIELD

(unit : kg/rai)

Year	Region	Province	Varieties	Paddy Yield
1970	North	Nan	Gam Pai 15**	1,408
	East-North	Mahasarakarm	Gam Pai 41**	1,297
	Central	Phichit	Nahng Mom 5-4**	1,325
	South	Ranong	Nahng Prayah 132*	1,110
1971	North	Nan	Niaw San-Pah-Tawng**	1,594
	East-North	Srisuket	Bang Khen 293*	1,272
	Central	Chaochen Sao	RD-1*	1,610
	South	Nakon Sritamarat	RD-1*	1,246
1972	North	Nan	Gam Pai 15**	1,355
	East-North	Nakon Panon	RD-1*	1,472
1973	Central	Phisanulok	RD-1*	1,537
	South	Narativas	Nahng Prayah 132*	1,098

Source: - Ministry of Agriculture and Cooperatives;
Program of Plowing Ceremony, 1974

*: Non-glutinous rice
**: Glutinous rice

BUILD-UP PERIOD AND TARGET YIELD OF EACH CROP
- WITH PROJECT -

(1) Huai Saduang Yai Sub-Project Area

		1st year	2nd year	3rd year	4th year	5th year
Paddy	(L.V)	550	580	610	630	640
	(H.Y.V)	700	730	760	780	800
Beans		150	180	200	220	240
Tobacco		310	340	360	380	400

(2) Huai Khon Kaen, Huai Yai and Khlong Chaliang Lab Sub-Project Areas

		1st year	2nd year	3rd year	4th year	5th year
Paddy	(L.V)	490	540	590	620	640
	(H.Y.V)	640	700	750	780	800
Beans		150	180	200	220	240
Tobacco		310	340	360	380	400

TABLE IV-19

ANNUAL CROP PRODUCTION AT FULL DEVELOPMENT STAGE IN THE PROJECT AREA

Sub-Area	Without or With	Area or Production	Rainy Season Paddy			Mungbeans	Tobacco	Maize
			Local Variety	High Yield Variety	Total			
(1) Huai Saduang Yai Sub-Project Area								
	Without:	Area (rai)	6,970	11,620	18,590	4,650	3,500	5,750
		Production (tons)	3,490	7,560	11,050	560	950	2,420
	With :	Area (rai)	10,125	23,625	33,750	5,060	6,750	0
		Production (tons)	6,480	18,900	25,380	1,220	2,700	0
(2) Huai Khon Kaen Sub-Project Area								
	Without:	Area (rai)	6,520	7,030	13,550	1,950	1,820	8,870
		Production (tons)	2,910	4,000	6,910	230	490	3,730
	With :	Area (rai)	9,570	22,310	31,880	4,780	6,380	0
		Production (tons)	6,120	17,860	23,980	1,150	2,560	0
(3) Huai Yai Sub-Project Area								
	Without:	Area (rai)	5,290	2,120	7,410	850	210	340
		Production (tons)	2,330	1,170	3,500	100	60	140
	With :	Area (rai)	3,375	7,875	11,250	1,690	2,250	0
		Production (tons)	2,160	6,300	8,460	410	900	0
(4) Khlong Chalıang Lab Sub-Project Area								
	Without:	Area (rai)	3,600	1,440	5,040	720	360	160
		Production (tons)	1,580	790	2,370	90	100	70
	With :	Area (rai)	2,250	5,250	7,500	1,125	1,500	0
		Production (tons)	1,440	4,200	5,640	270	600	0

INCREASE CROP PRODUCTION AT THE FULL DEVELOPMENT STAGE
IN THE PROJECT AREA

(Unit: tons)

Sub-Area	Without or With	Rainy Season Paddy			Mungbeans	Tobacco	Maize
		Local Variety	High Yield Variety	Paddy Total			
Huai Saduang Yai Sub-Project Area							
	Without	3,490	7,560	11,050	560	950	2,420
	With	6,480	18,900	25,380	1,220	2,700	0
	Increment	2,990	11,340	14,330	660	1,750	-2,420
Huai Khon Kaen Sub-Project Area							
	Without	2,910	4,000	6,910	230	490	3,730
	With	6,120	17,860	23,980	1,150	2,560	0
	Increment	3,210	13,860	17,070	920	2,070	-3,730
Huai Yai Sub-Project Area							
	Without	2,330	1,170	3,500	100	60	140
	With	2,160	6,300	8,460	410	900	0
	Increment	-170	5,130	4,960	310	840	-140
Khlong Chaliang Lab Sub-Project Area							
	Without	1,580	790	2,370	90	100	70
	With	1,440	4,200	5,640	270	600	0
	Increment	-140	3,410	3,270	180	500	-70
Whole Project Area							
	Without	10,310	13,520	23,830	980	1,600	6,360
	With	16,200	47,260	63,460	3,050	6,760	0
	Increment	5,890	33,740	39,630	2,070	5,160	-6,360

PRICES FOR MAJOR FARM INPUTS AND OUTPUTS, ETC.

Item		Financial Prices (฿/ton or lit.)	Economic Prices (฿/ton or lit.)	Remarks
Farm Products,	Rice (L.V.)/1	5,200	11,500	
	(H.Y.V.)	5,500	12,100	
	Paddy (L.V.)/1	2,700	7,500	Dry paddy
	(H.Y.V.)	2,800	7,900	Dry paddy
	Maize	2,400	3,900	
	Mungbeans	8,500	13,000	
	Soybeans	7,000		
	Tobacco	28,000	43,100	
Seed,	Paddy	4,000	10,000	
	Maize	6,000	9,000	
	Mungbeans	10,000	15,000	
Seedling,	Tobacco	35	53	1,000 trees
Fertilizer,	Urea	6,000	10,600	
	Mixed fertilizer	8,000	12,800	
Agro-chemical,	Insecticides	180	300	Liter
	Fungicides	150	250	Liter
	Rodenticides	2	3	100 g
Livestock,	Chicken	37		1 head
	Duck	40		1 head
	Egg	1.5		1 head
Labor	Light	60.0	30.0/2	1 person/day
	Heavy	80.0	40.0/3	1 person/day

/1: About 95% of price for H.Y.V.

/2: ฿34/man-day in 1990 after inclusion of the real increase at the rate of 1.5%/year.

/3: ฿45/man-day in 1990 after inclusion of the real increase at the rate of 1.5%/year.

ECONOMIC PRICE OF RICE/PADDY AND MUNGBEANS

(1982 Constant Dollar)

Item	Rice/Paddy (฿/ton)	Rice/Paddy Balance (฿/ton)	Mungbeans (฿/ton)	Mungbeans Balance (฿/ton)
FOB Bangkok	15,226 (US$662) ≒15,230 /1		17,880 (US$777.4) /2	
Quality discount	1,520	13,710	900	16,980
Storage loss	550	13,160	850	16,130
Warehouse cost	60	13,100	60	16,070
Transportation cost /3 (Bangkok-Phetchabun/Lom Sak)	600	12,500	650	15,420
Processing cost, etc.	200 /4	12,300	1,530 /5	13,890
Ex.-mill price of rice	12,300		-	
Ex.-mill price of paddy	7,995		-	
Price of paddy at mill	7,995	7,995	-	
Local storage loss	-		700	13,190
Local transportation cost /3	140	7,855	150	13,040
Farm gate price	7,855 ≒ 7,900		13,040 ≒ 13,000	

/1: Price in 1990 at 1982 constant US dollar forecasted in the Documents of the IBRD, June 1981, "Price Prospects for Major Primary Commodities".

/2: Price in 1990 at 1982 constant US dollar forecasted based on the exported price at Bangkok for past 6 years and using the International Market Price Index of IBRD, June 1981, "Price Prospects for Major Primary Commodities".

/3: S.C.F. of 0.79 is applied in the estimation.

/4: Milling charge.

/5: Including the cost for bag, etc.

ECONOMIC PRICE OF TOBACCO

	Economic Price (baht/ton)	(1982 constant US$)
FOB Bangkok[/1] US$3,215	฿73,957 ≒ 73,960	Forecast Price in 1990
Quality discount	14,790	59,170
Storage loss	2,960	56,210
Warehouse cost	120	56,090
Transportation cost[/2] (Bangkok-Phetchabun/Lom Sak)	790	55,300
Ex.-factory price of Tobacco	55,300	
Factor processing and handling cost	8,260	47,040
Local transportation cost[/2]	200	46,840
Ex.-curing materials of Tobacco at farm gate	3,730	43,110
Farm gate price	43,110	43,100

/1: Forecast price of Tobacco in 1990 at 1982 constant price is based on the exported price of Bangkok for past 6 years which is converted by using International Price Index of the IBRD, June 1981 "Price Prospects for Major Primary Commodities".

/2: The Standard Conversion Factor (S.C.F.) of 79% is applied.

ECONOMIC PRICE OF FARM INPUTS

I. Urea

		Forecast Price in 1990 Baht/ton
a)	Financial Price	
	Projected farm gate price	6,000
b)	Economic Price	
	Projected World Price in 1982 US$ in 1990, $325 (FOB Europe Bagged)	7,475
	(Plus) Transport cost to Asian Market of US$30	690
	(Equals) CIF Bangkok US$345	8,165
	(Plus) Distribution costs to farm gate	10,615
	(Equals) Value at farm gate	10,600
	Say	10,600

II. The prices of other farm inputs are projected based on the International Market Price Index by the Document of the IBRD, June 1981 "Price Prospects for Major Primary Commodities".

FUTURE AMOUNT OF FARM INPUTS

	Rainy Season Paddy		Mungbeans	Tobacco
	(L.V)	(H.Y.V)		
Seed (kg/rai)	5.0	5.0	6.0	4,000*
Fertilizer				
Urea (kg/rai)	10	15	-	50
Mixed fertilizer (kg/rai)	10	20	10	150
Agro-chemicals				
Insecticides (lit./rai)	0.40	0.40	0.30	1.0
Fungicides (lit./rai)	0.20	0.20	0.10	0.50
Rodenticides (gr./rai)	40	40	30	-

Reference Data : - Farm Economy Survey, 1982
- Provincial Agricultural Office, 1982
- Branch of Economy Section, RID, 1981
- Branch of Irrigated Agriculture Section,
- RID, 1981

* : No. of Seedling

FUTURE LABOR REQUIREMENT FOR CROPS

(Unit ; man-days rai)

	Rainy Season Paddy		Mungbeans	Tobacco
	(L.V)	(H.Y.V)		
Nursery	0.10	0.12	-	0.50
Plowing	0.40	0.45	0.20	0.20
Harrowing	0.40	0.45	0.10	0.30
Paddling	0.15	0.16	-	0.10
Transplanting or Sowing	2.60	2.80	0.20	6.00
Weeding	0.30	0.30	1.00	3.50
Fertilizing	0.15	0.18	0.10	2.00
Spraying	0.20	0.22	0.20	3.00
Water Control	0.25	0.25	0.10	0.20
General Observe	0.15	0.16	-	0.20
Harvesting	3.25	3.95	2.50	12.00
Threshing	1.50	1.80	0.50	11.50
Others	1.00	1.00	0.50	4.50
Total	10.45	11.84	5.40	44.0

Reference Data : - Farm Economy Survey, 1982
- Provincial Agricultural Office, 1982
- Branch of Economy Section, RID, 1981
- Branch of Irrigated Agriculture
- Section, RID, 1981

MONTHLY LABOR REQUIREMENT FOR CROP CULTIVATION IN EACH SUB-AREA

(unit : men/day)

Huai Saduang Yai Sub-Project Area

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Paddy L.V. (2.64 rai)						1.31	4.35	5.55	1.05	0.53	4.62	10.16	27.57
H.Y.V. (6.16 rai)					2.28	9.17	13.98	3.94	12.8	15.33	15.39		72.89
Beans (1.32 rai)	0.93	3.84	0.80								0.67	0.93	7.17
Tobacco (1.76 rai)	19.54	16.02	9.41	5.28					0.53	6.96	8.62	11.09	77.45
Upland crops (14.3 rai)				26.60	46.90	7.87	44.19						125.56
Total	20.47	19.86	10.21	31.88	49.18	18.35	62.52	9.49	14.38	22.82	29.30	22.18	310.64
Available farm family labor/1	62.5	62.5	62.5	62.5	62.5	62.5	62.5	62.5	62.5	62.5	62.5	62.5	750.0
Shortage of labor force							-0.02						

Huai Yai Sub-Project Area

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Paddy L.V. (2.64 rai)						1.50	4.95	6.30	1.20	0.60	5.24	11.55	31.34
H.Y.V. (6.16 rai)					2.59	10.43	15.89	4.48	14.56	17.43	17.50		82.88
Beans (1.32 rai)	1.05	4.35	0.90								0.74	1.05	8.09
Tobacco (1.76 rai)	22.20	18.20	10.70	6.00					0.60	7.90	9.80	12.60	88.00
Upland crops (14.3 rai)				17.67	31.16	5.22	29.35						83.40
Total	23.25	22.55	11.60	23.67	33.75	17.15	50.19	10.78	16.36	25.93	33.28	25.20	293.71
Available farm family labor/1	62.5	62.5	62.5	62.5	62.5	62.5	62.5	62.5	62.5	62.5	62.5	62.5	750.0

Huai Khon Kaen Sub-Project Area

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Paddy L.V. (2.70 rai)						1.36	4.46	5.67	1.07	0.54	4.73	10.40	28.23
H.Y.V. (6.30 rai)					2.32	9.39	14.30	4.03	13.09	15.69	15.74		74.56
Beans (1.35 rai)	0.95	3.92	0.81								0.68	0.95	7.31
Tobacco (1.80 rai)	19.97	16.37	9.63	5.40					0.54	7.11	8.83	11.34	79.19
Upland crops (13.1 rai)				24.36	42.97	7.21	40.47						115.01
Total	20.92	20.29	10.44	29.76	45.29	17.96	59.23	9.70	14.70	23.34	29.98	22.69	304.3
Available farm family labor/1	62.5	62.5	62.5	62.5	62.5	62.5	62.5	62.5	62.5	62.5	62.5	62.5	750.0

Khlong Chaliang Lab Sub-Project Area

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Paddy L.V. (2.70 rai)						1.39	4.60	5.86	1.11	0.56	4.89	10.74	29.15
H.Y.V. (6.30 rai)					2.41	9.70	14.78	4.17	13.54	16.21	16.27		77.08
Beans (1.35 rai)	0.90	4.06	0.84								0.69	0.98	7.55
Tobacco (1.80 rai)	20.64	16.92	9.95	5.58					0.56	7.35	9.12	11.72	81.84
Upland crops (13.1 rai)				21.21	37.39	6.27	35.22						100.09
Total	21.54	20.98	10.79	26.79	39.80	17.36	54.60	10.03	15.21	24.12	30.97	23.44	295.71
Available farm family labor/1	62.5	62.5	62.5	62.5	62.5	62.5	62.5	62.5	62.5	62.5	62.5	62.5	750.0

/1: 2.5 persons per farm household x 25 days/month = 62.5 persons/month

Note: L.V.; Local Variety
H.Y.V.; High Yield Variety

CROP PRODUCTION COST IN "WITHOUT PROJECT" AND "WITH PROJECT"

(unit : ฿/rai)

(1) "Without" Crop Production Cost

Item	Rainy Season Paddy (L.V.)	Rainy Season Paddy (H.Y.V.)	Mungbeans	Tobacco	Maize
I. Variable Cost	760	865	238	2,968	294
1. Land cost for/and land preparation	626	698	147	1,204	234
1.1 Labor cost for planting	349	380	45	613	136
1.2 Labor cost for harvesting	277	318	102	591	98
2. Material cost	93	111	91	1,746	60
3. Others	41	56	-	18	-
II. Fixed Cost	61	79	4	10	4
Total cost/rai	821	944	242	2,978	298

(2) "With" Crop Production Cost

Item	Rainy Season Paddy (L.V.)	Rainy Season Paddy (H.T.V.)	Mungbeans	Tobacco
I. Variable Cost	1,140	1,382	533	4,753
1. Land cost for/and land preparation	663	723	217	1,656
1.1 Labor cost for planting	353	364	96	704
1.2 Labor cost for harvesting	310	359	121	952
2. Material cost	432	598	307	3,057
3. Others	45	61	9	40
II. Fixed Cost	65	84	3	35
Total cost/rai	1,205	1,466	536	4,788

Reference Data:
- Branch of Economy Section, RID, 1981
- Branch of Irrigated Agricultural Section, RID, 19i1
- Provincial Agricultural Office, 1982
- Farm Economy Survey, 1982
- Tobacco Monopoly Office in Phetchabun, 1982

GROSS AND NET PRODUCTION VALUE AT FULL DEVELOPMENT STAGE IN "WITHOUT PROJECT" CONDITION

Major Crops	Cropped Area (rai)	Production (ton)	Unit Price (฿10³/ton)	Gross Value (฿10³)	Unit Production Cost (฿/rai)	Total Production Cost (฿10³)	Net Production Value (฿10³)
(1) Huai Saduang Yai Sub-Project Area							
Paddy (L.V.)	6,970	3,490	7,500	26,175	821	5,722	20,453
(H.Y.V.)	11,620	7,560	7,900	59,724	944	10,969	48,755
Paddy total	18,590	11,050		85,899		16,691	69,208
Beans	4,650	560	13,000	7,280	242	1,125	6,155
Tobacco	3,500	950	43,100	40,945	2,978	10,423	30,522
Maize	5,750	2,420	3,900	9,438	298	1,714	7,724
Total				143,562		29,953	113,609
(2) Huai Khon Kaen Sub-Project Area							
Paddy (L.V.)	6,520	2,910	7,500	21,825	821	5,353	16,472
(H.Y.V.)	7,030	4,000	7,900	31,600	944	6,636	24,964
Paddy total	13,550	6,910		53,425		11,989	41,436
Beans	1,950	230	13,000	2,990	242	472	2,518
Tobacco	1,820	490	43,100	21,119	2,978	5,420	15,699
Maize	8,870	3,730	3,900	14,547	298	2,644	11,903
Total				92,081		20,525	71,556
(3) Huai Yai Sub-Project Area							
Paddy (L.V.)	5,290	2,330	7,500	17,475	821	4,343	13,132
(H.Y.V.)	2,120	1,170	7,900	9,243	944	2,001	7,242
Paddy total	7,410	3,500		26,718		6,344	20,374
Beans	850	100	13,000	1,300	242	206	1,094
Tobacco	210	60	43,100	2,586	2,978	625	1,961
Maize	340	140	3,900	546	298	101	445
Total				31,150		7,276	23,874
(4) Khlong Chaliang Lab Sub-Project Area							
Paddy (L.V.)	3,600	1,580	7,500	11,850	821	2,956	8,894
(H.Y.V.)	1,440	790	7,900	6,241	944	1,359	4,882
Paddy total	5,040	2,370		18,091		4,315	13,776
Beans	720	90	13,000	1,170	242	174	996
Tobacco	360	100	43,100	4,310	2,978	1,072	3,238
Maize	160	70	3,900	273	298	48	225
Total				23,844		5,609	18,235

GROSS AND NET PRODUCTION AT FULL DEVELOPMENT STAGE IN "WITH PROJECT" CONDITION

Major Crops	Cropped Area (rai)	Production (tons)	Unit Price (฿/10^3ton)	Gross Value (฿10^3)	Unit Production Cost (฿10^3)	Total Production Cost (฿103)	Net Production Value (฿10^3)
(1) Huai Saduang Yai Sub-Project Area							
Paddy (L.V.)	10,125	6,480	7,500	48,600	1,205	12,201	36,399
(H.Y.V.)	23,625	18,900	7,900	149,310	1,466	34,634	114,676
Paddy total	33,750	25,380		197,910		46,835	151,075
Beans	5,060	1,220	13,000	15,860	536	2,712	13,148
Tobacco	6,750	2,700	43,100	116,370	4,788	32,319	84,051
Total				330,140		81,866	248,274
(2) Huai Khon Kaen Sub-Project Area							
Paddy (L.V.)	9,570	6,120	7,500	45,900	1,205	11,532	34,368
(H.Y.V.)	22,310	17,860	7,900	141,094	1,466	32,706	108,388
Paddy total	31,880	23,980		186,994		44,238	142,756
Beans	4,780	1,150	13,000	14,950	536	2,562	12,388
Tobacco	6,380	2,560	43,100	110,336	4,788	30,547	79,789
Total				312,280		77,347	234,933
(3) Huai Yai Sub-Project Area							
Paddy (L.V.)	3,375	2,160	7,500	16,200	1,205	4,067	12,133
(H.Y.V.)	7,875	6,300	7,900	49,770	1,466	11,545	38,225
Paddy total	11,250	8,460		65,970		15,612	50,358
Beans	1,690	410	13,000	5,330	536	906	4,424
Tobacco	2,250	900	43,100	38,790	4,788	10,773	28,017
Total				110,090		27,291	82,799
(4) Khlong Chaliang Lab Sub-Project Area							
Paddy (L.V.)	2,250	1,440	7,500	10,800	1,205	2,711	8,089
(H.Y.V.)	5,250	4,200	7,900	33,180	1,466	7,697	25,483
Paddy total	7,500	5,640		43,980		10,408	33,572
Beans	1,125	270	13,000	3,510	536	603	2,907
Tobacco	1,500	600	43,100	25,860	4,788	7,182	18,678
Total				73,350		18,193	55,157

NET INCREMENTAL BENEFIT IN THE PROJECT AREA

(unit : ฿10^3)

Sub-Area	Without or With	Rainy Season Paddy			Beans	Tobacco	Maize	Grand Total
		Local Variety	High Yield Variety	Total				
Huai Saduang Yai Sub-Project Area								
	Without	20,453	48,755	69,208	6,155	30,522	7,724	113,609
	With	36,399	114,676	151,075	13,148	84,051	-	248,274
	Increment	15,946	65,921	81,867	6,993	53,529	-7,724	134,665
Huai Khon Kaen Sub-Project Area								
	Without	16,472	24,964	41,436	2,518	15,699	11,903	71,556
	With	34,368	108,388	142,756	12,388	79,789	-	234,933
	Increment	17,896	83,424	101,320	9,870	64,090	-11,903	163,377
Huai Yai Sub-Project Area								
	Without	13,132	7,242	20,374	1,094	1,961	445	23,874
	With	12,133	38,225	50,358	4,424	28,017	-	82,799
	Increment	-999	30,983	29,984	3,330	26,056	-445	58,925
Khlong Chaliang Lab Sub-Project Area								
	Without	8,894	4,882	13,776	996	3,238	225	18,235
	With	8,089	25,483	33,572	2,907	18,678	-	55,157
	Increment	-805	20,601	19,796	1,911	15,440	-225	36,922
Total Project Area								
	Without	58,951	85,843	144,794	10,763	51,420	20,297	227,274
	With	90,989	286,772	377,761	32,867	210,535	-	621,163
	Increment	32,038	200,929	232,967	22,104	159,115	-20,297	393,889

TYPICAL FARM BUDGET IN "WITH PROJECT"

(unit : baht)

Sub-Area	Huai Saduang Yai Sub-Project Area	Huai Khon Kaen Sub-Project Area	Huai Yai Sub-Project Area	Khloang Chaliang Lab Sub-Project Area
Family Size	5.5 persons	6.5 persons	5.5 persons	5.5 persons
Farm Size - paddy field /1	8.8 rai	9.0 rai	10.0 rai	9.3 rai
- upland field	14.3 rai	13.1 rai	9.5 rai	11.4 rai
1. Gross Income				
Farm income	55,180	54,897	55,900	54,562
Paddy (L.V.)	4,562	4,666	5,184	4,821
(H.Y.V.)	13,799	14,112	15,680	14,582
Beans	2,693	2,754	3,060	2,836
Tobacco	19,712	20,160	22,400	20,832
Upland crops	14,414	13,205	9,576	11,491
Livestock income	954	1,494	1,343	1,376
Miscellaneous income	445	1,550	2,070	1,230
Total	56,579	57,941	59,313	57,168
2. Outgo				
Farm expenses	13,328	13,356	13,931	13,415
Paddy (L.V.)	1,344	1,375	1,528	1,421
(H.Y.V.)	4,081	4,174	4,638	4,313
Beans	462	472	525	486
Tobacco	4,866	4,976	5,529	5,142
Upland crops	2,575	2,359	1,711	2,053
Livestock expenses	86	134	121	124
Tax, etc.	206	192	265	295
Family living expenses	35,210	36,220	35,210	35,210
Total	48,830	49,902	49,527	49,044
3. Balance or Capacity to Pay	7,749	8,039	9,786	8,124
(US$)	336.9	349.5	425.5	353.2

/1: Including the areas which the farmers possess outside the project area.

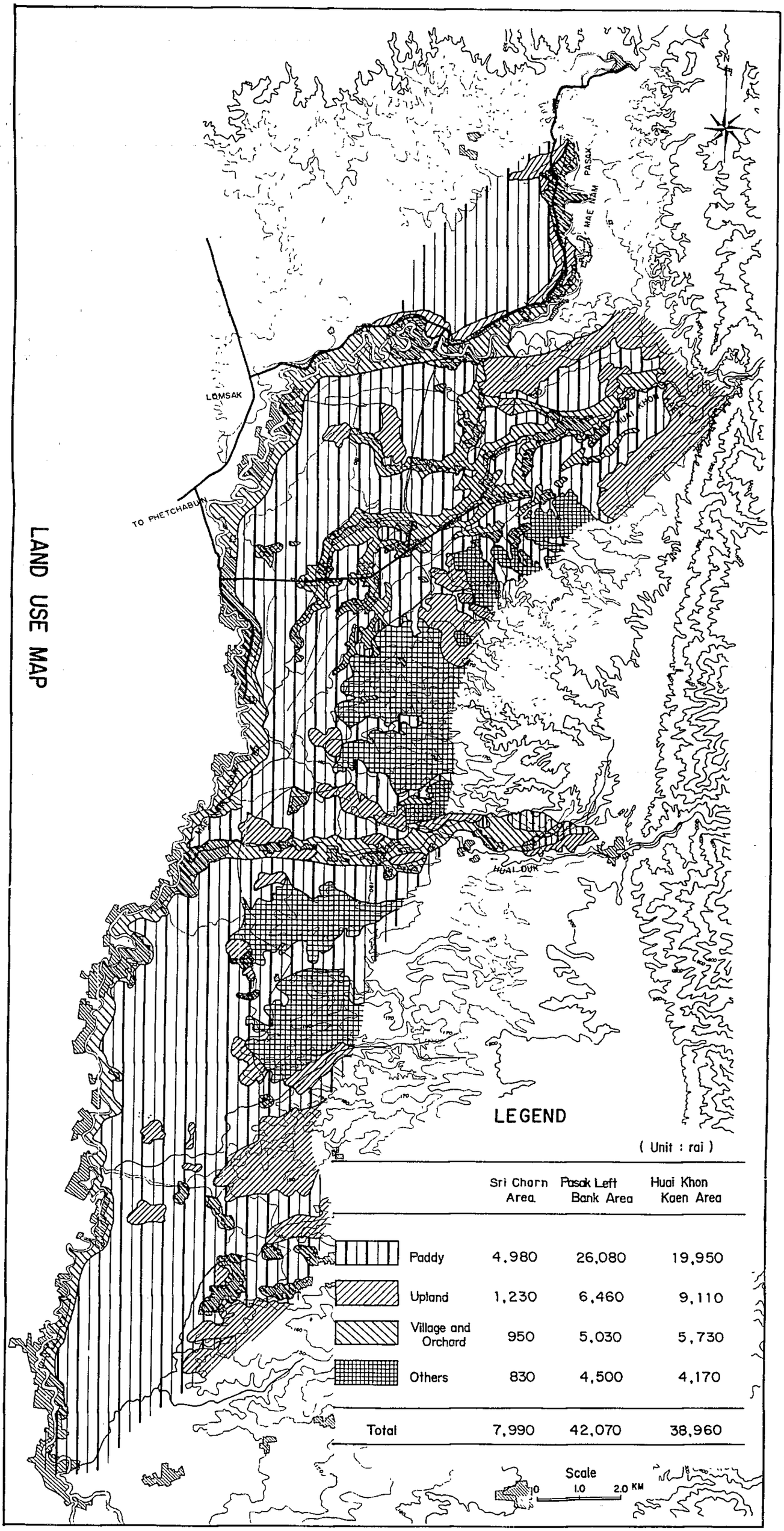
TYPICAL FARM BUDGET IN "WITHOUT PROJECT"

(unit ; baht)

Sub-Area	Huai Saduang Yai Sub-Project Area	Huai Khon Kaen Sub-Project Area	Huai Yai Sub-Project Area	Khloang Chaliang Lab Sub-Project Area
Family Size	5.5 persons	6.5 persons	5.5 persons	5.5 persons
Farm Size - paddy field /1	7.3 rai	6.5 rai	9.8 rai	9.1 rai
- upland field	15.8 rai	15.6 rai	9.7 rai	11.6 rai
1. Gross Income				
Farm income	33,524	27,405	20,860	24,244
Paddy (L.V.)	2,457	2,233	5,643	5,299
(H.Y.V.)	5,515	2,895	2,926	2,741
Beans	1,234	479	775	908
Tobacco	6,880	3,553	1,436	3,402
Upland crops /1	17,438	18,245	10,080	11,894
Livestock income	1,280	1,899	1,566	1,626
Miscellaneous income	890	3,100	6,900	4,100
Total	35,694	32,404	29,326	29,970
2. Outgo				
Farm expenses	6,340	5,237	4,086	4,787
Paddy (L.V.)	475	491	1,239	1,164
(H.Y.V.)	906	562	568	532
Beans	221	86	139	163
Tobacco	1,622	838	339	803
Upland crops	3,116	3,260	1,801	2,125
Livestock expense	128	190	157	164
Tax, etc.	140	130	180	200
Family living expenses	28,300	26,800	24,850	24,770
Total	34,908	32,357	29,273	29,921
3. Balance or Capacity to Pay	786	47	53	49
(US$)	34.2	2.0	2.3	2.1

/1: Including the areas which the farmers possess outside the project area.

LAND USE MAP

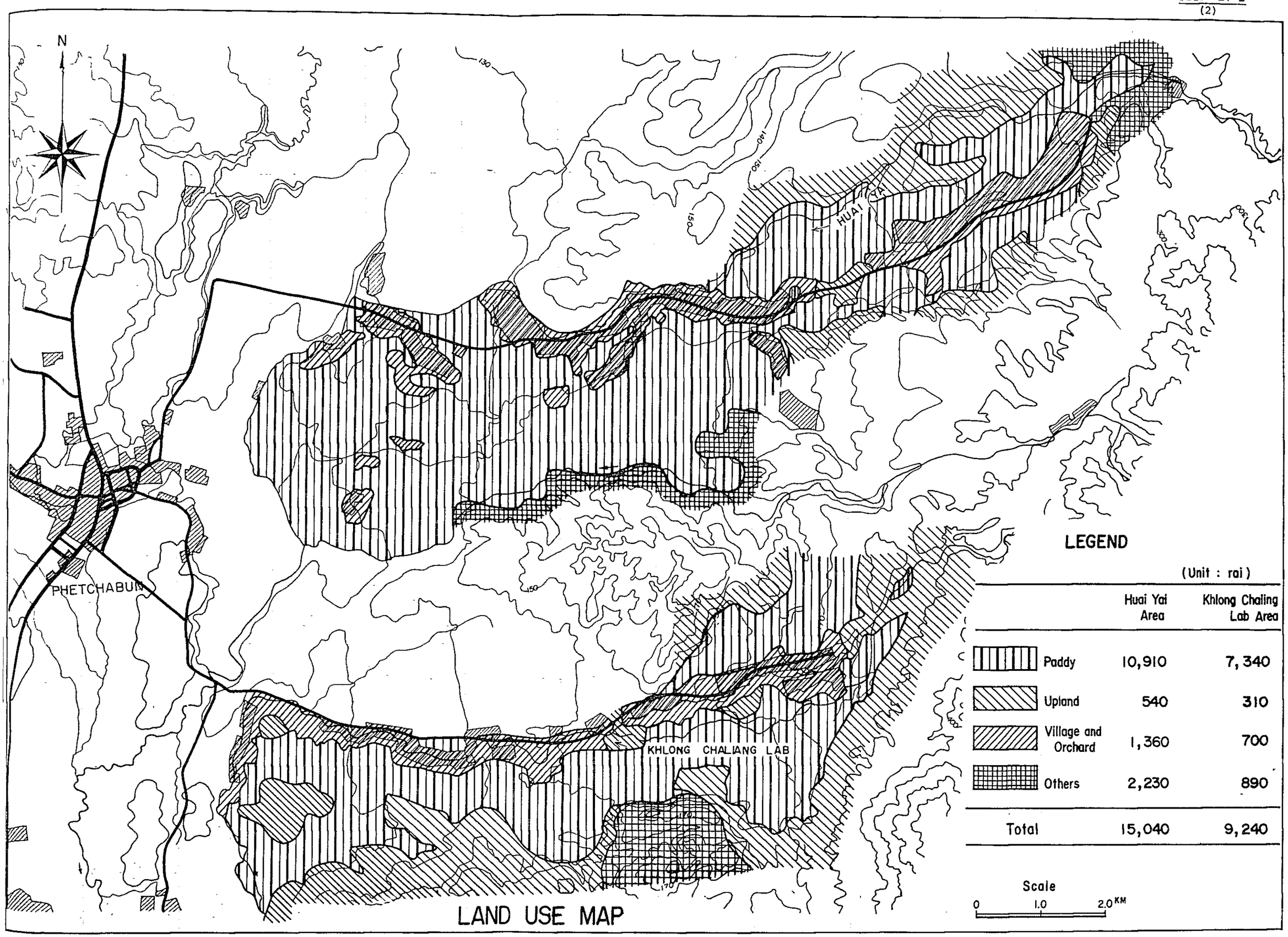


(Unit : rai)

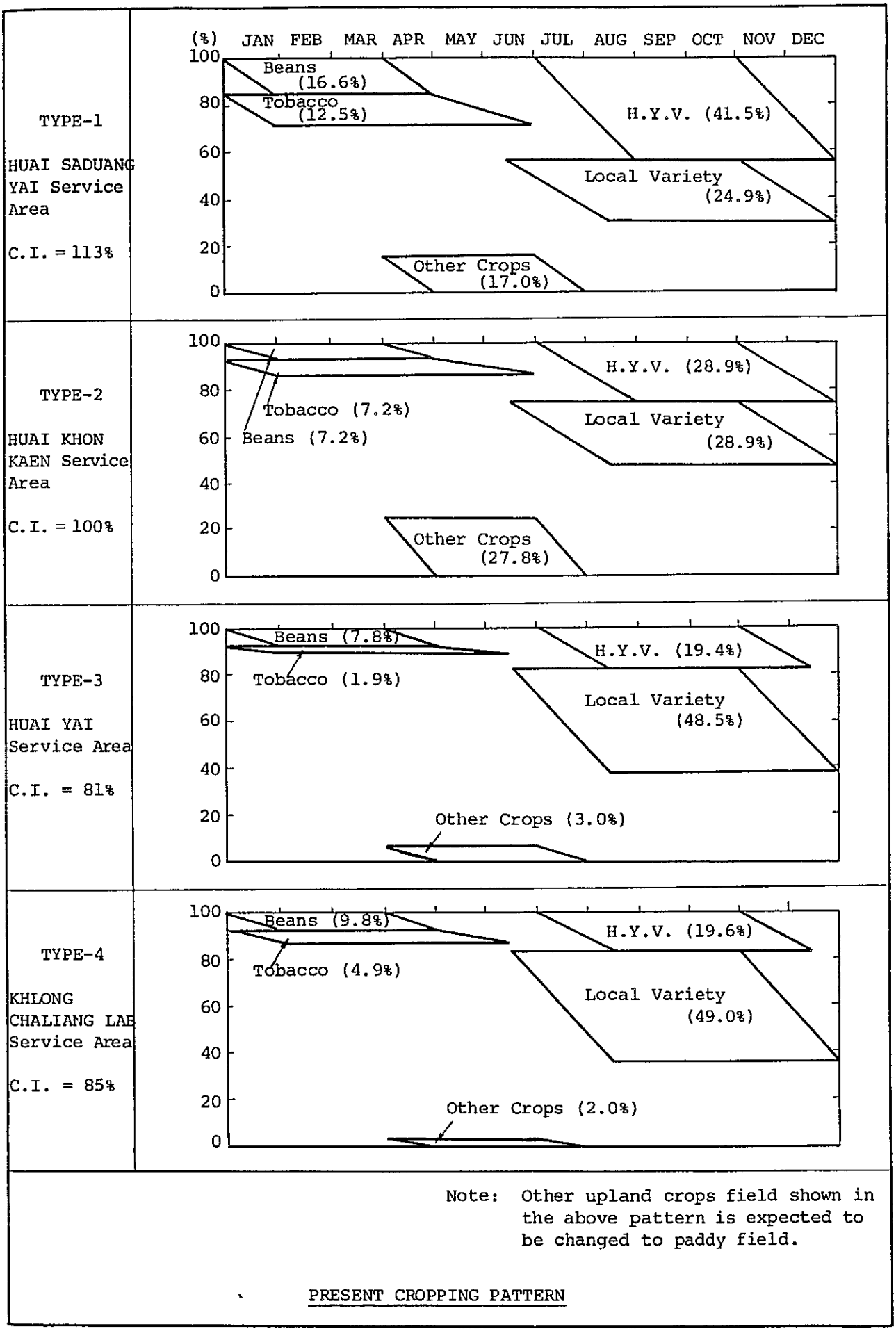
	Sri Chorn Area	Pasak Left Bank Area	Huai Khon Kaen Area
Paddy	4,980	26,080	19,950
Upland	1,230	6,460	9,110
Village and Orchard	950	5,030	5,730
Others	830	4,500	4,170
Total	7,990	42,070	38,960

Scale 0 1.0 2.0 KM

FIG. IV-1 (1)


N
130
140
150
150
HUAI YAI
KHLONG CHALIANG LAB
PHETCHABURI
LEGEND
(Unit : rai)
Huai Yai Area
Khlong Chaling Lab Area
Paddy 10,910 7,340
Upland 540 310
Village and Orchard 1,360 700
Others 2,230 890
Total 15,040 9,240
Scale
0 1.0 2.0 KM

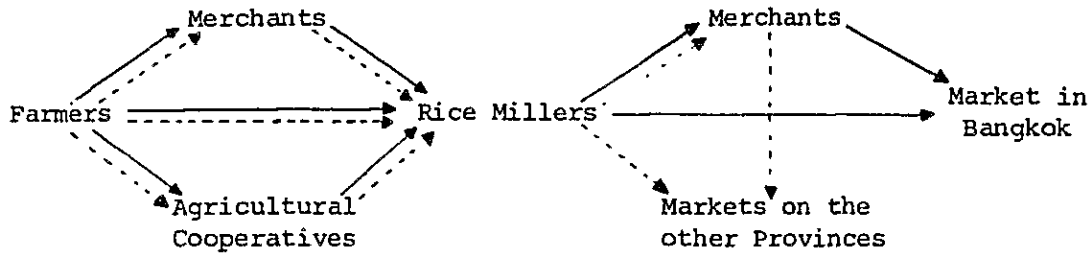
LAND USE MAP



Note: Other upland crops field shown in the above pattern is expected to be changed to paddy field.

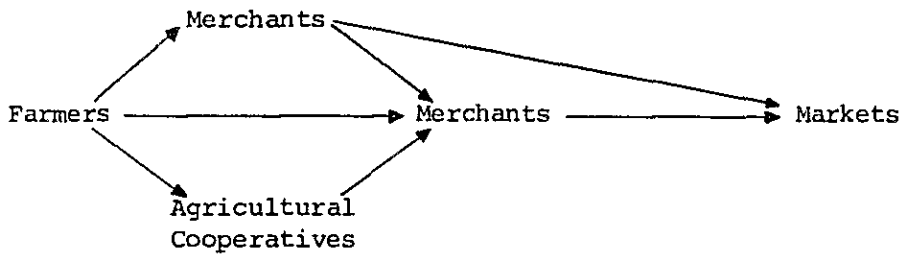
PRESENT CROPPING PATTERN

Paddy

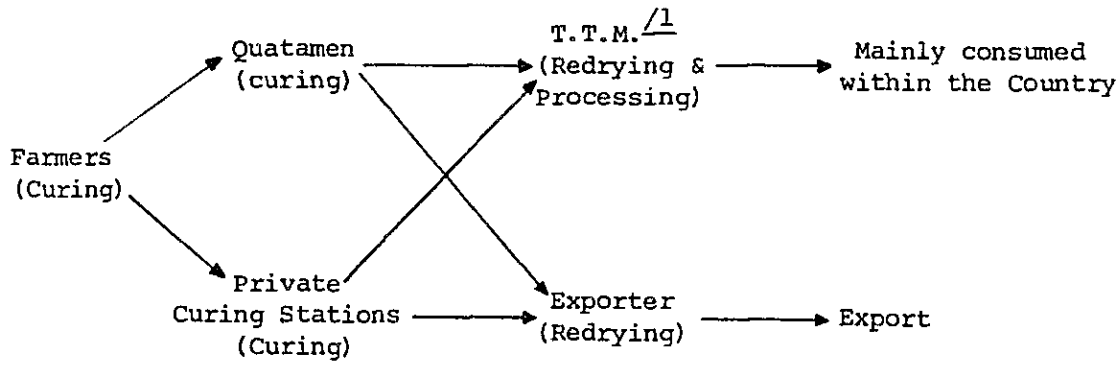


Note : ——→ Glutinous Rice ----------→ Non-glutinous Rice

Munabeans



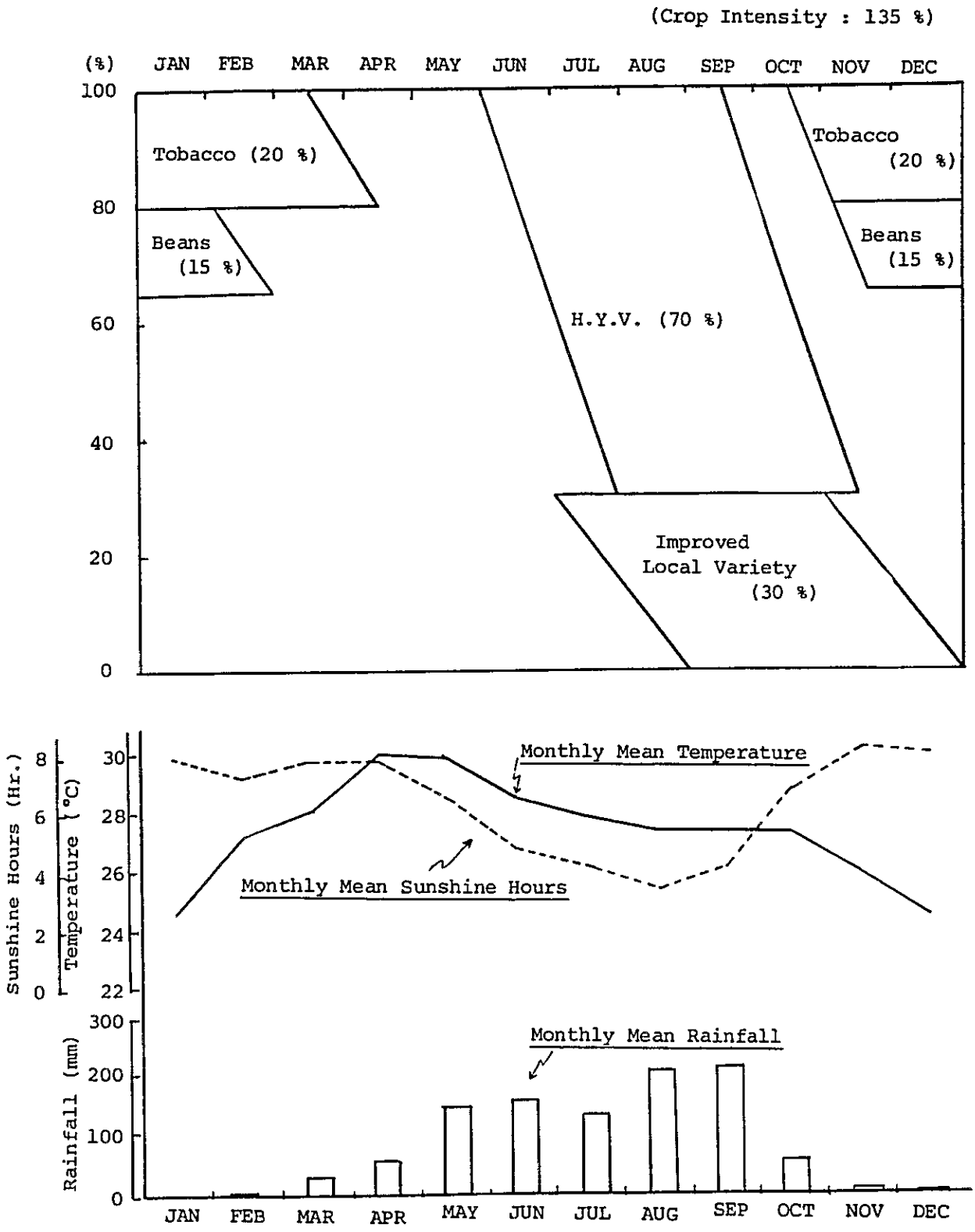
Tobacco



/1 : T.T.M. = Thai Tobacco Monopoly

Source : The Mae Wang - Kew Lom Irrigated Agricultural Development Project Main Report, March 1980 JICA

MARKETING FLOWS OF MAJOR CROPS



PROPOSED CROPPING PATTERN