THE KINGDOM OF THAILAND

PRELIMINARY PLAN

OF

THE AGRICULTURAL DEVELOPMENT RESEARCH PROJECT

IN NORTHEAST THAILAND

MARCH 1983

JAPAN INTERNATIONAL COOPERATION AGENCY

PREFACE

In response to the request of the Government of the Kingdom of Thailand, the Government of Japan decided to conduct a survey on the agricultural conditions and production constraints in the northeastern region of Thailand under the Agricultural Development Research Project in Northeast Thailand and entrusted the survey to the Japan International Cooperation Agency (JICA). The JICA sent to Thailand a survey team headed by Mr. SADAO HATTA, Senior Researcher of the Tropical Agriculture Research Center, Ministry of Agriculture, Forestry and Fisheries of Japan, from November 15 to December 20, 1982.

The team exchanged views with the officials concerned of the Government of Thailand and conducted a field survey (on assessment of natural environment and natural resources; improvement of crop performance with development of agronomic technology; conservation of soil fertility through soil and water management research and fertilizer application). After the team returned to Japan, further studies were made and the present report has been prepared.

I hope that this report will serve for the development of the Project and contribute to the promotion of friendly relations between our two countries.

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

March , 1983

Keisuke Arita

President

Japan International Cooperation Agency

Acknowledgement

The present paper entitled "Preliminary Plan of the Agricultural Development Research Project in Northeast Thailand" was prepared by the mission which was sent to Thailand for five weeks starting from 15 November 1982 by the Japan International Cooperation Agency.

The mission consisted of Messrs. Sadao Hatta (Agronomist and Team Leader), Jun-ichiro Kawakami (Plant Breeder) and Masanori Miyake (Soil Scientist). The assignment of the mission was to investigate the existing agricultural conditions and production constraints in the Northeast by visiting various research institutions and organizations concerned, and to collect information necessary to prepare a master plan of the Project. The present paper was prepared based on the information obtained by the mission, for review by the Government of Thailand.

The mission would like to take this opportunity to express its deep appreciation to the Government of Thailand for the thoughtful support and arrangements which enabled the mission to complete the task within a limited period of time.

The mission is most grateful to the excellent leadership of Dr. Thaleng Thamrong-Nawasawat, Under-Secretary of the State, Ministry of Agriculture and Cooperatives, to guide the mission and convene the meeting at his Office on 17 December 1982 to discuss a draft outline of the master plan prepared by the mission.

The mission would like to express its sincere gratitude to Mr. Apilas Ostananda, Director-General, Department of Technical and Economic Cooperation, for the kind support extended to the mission.

Sincere thanks are due to Mr. Yookti Sarikaphuti, Director-General of the Department of Agriculture, Ministry of Agriculture and Cooperatives, and Mr. Anunt Komes, Director-General of the Land Development Department, the same Ministry, as well as their staff members for their kind arrangements and hospitality to provide the mission with all the necessary facilities including office space, able coordinators and transportation for the trip to the Northeast.

Special thanks are also due to Dr. Kavi Chutikul, Dean of the Faculty of Agriculture, Khon Kaen University, and his staff members for the support and hospitality extended to the mission during the visit to Khon Kaen.

It is difficult to write the names of all personnel who have kindly assisted the mission but, the mission would like to sincerely thank the Directors and staff members of Offices such as the Northeast Regional Office of Agriculture and Cooperatives, experiment stations, land development centers and irrigation projects which have been visited by the mission.

Lastly but not least, the mission is grateful to Mr. Robert Halligan, Director of the United States Agency for International Development and his staff members who kindly spared their time to exchange opinions with the mission.

Sadao Hatta
Team Leader
The Mission

Summary

The Northeast constitutes one third of both the population and land area of the whole Kingdom but is responsible for only 15% of the gross domestic products. The region was developed so rapidly since late 1940's that there hardly exist any virgin lands to reclaim for agricultural production. Alternate occurrence of drought and flood in every year accelerates degradation of natural environment and land productivity.

The present project is intended to strengthen the research activities for : assessment of natural environment and resources to design plans for proper land use in the Northeast; development of agronomic technology adaptable to each locality; and identification and elimination of the existing production constraints.

For this purpose, it is suggested that the research capabilities of the three research institutions, which play a leading role in the aforementioned research fields in the Northeast, will be strengthened under the Project especially in terms of research equipment/instruments and expertise. These research institutions are: the Department of Agriculture, Ministry of Agriculture and Cooperatives; the Land Development Department, the same Ministry; and the Faculty of Agriculture, Khon Kaen University.

While research activities will be undertaken by the three research institutions according to their mandate, the research activities should be directed towards the common target; that is, development of agricultural technology adaptable to each locality of the Northeast possibly with minimum inputs.

In this connection, it is suggested to establish a research center as a coordinating body to perform the following activities : coordinating

research activities; maintaining laboratories equipped with special apparatus and instruments for the common use; scientific and technological information services; and maintaining conference facilities.

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Topography and Soils in the Northeast

1. Physiography and Geology

The Korat Plateau is composed mainly of the broad terraces of the Mekong River and its tributaries. It is bordered on the west by the Phetchabun Range and on the south by the Dangrek Range. The Plateau is separated into two basins, the Sakon Nakhon Basin and the Korat Basin, by the Phu Phan Range in the northeast. (Fig. 2)

The whole sequence of the sediments in the Plateau commonly called the Korat group, is typically a post orogenic molasse facies indicating stable conditions. The sediments were derived from the mountains which were formed in the orogenic stage and included plutonic rocks emplaced during folding as a part of the parent materials. In several regions, salt and other evaporite deposits occur, associated with the arenaceous sediments.

The main landscape features are Quarternary river terraces, of which three levels have been recognized i.e. the low, middle and high terraces. The low terrace is dominant in the catchment area of the Mun River system. The northern part of the Plateau is predominantly occupied by middle terrace. Isolated remnants of high terrace are found in many places in the plateau. Strings of these remnants seem to accompany the valleys of the Chi and Mun Rivers. The largest high terrace areas occur to the south of Nakhon Ratchasima.

River alluvium is found along all streams; the width of these alluvial plains varies considerably. In the wider parts shallow intermittent lakes are numerous. Isolated low hills and hill ranges occur on the marginal areas of the basin of the Mun river system and in the northern part of the region. Volcanic outcrops and cones are found to the south of the Mun River. (Fig. 3, 4 and 5).

2. Topography and Texture of Parent Materials

Alluvial plains are most extensive along the Mun River including its southern tributaries and the Chi River including its northwestern tributaries, but very rare along the Mekong River. The texture of the alluvium plains is loamy on the levee and clayey in the basins.

The low terrace occurs just above the alluvial plains and is most extensive in the south-central and south-eastern parts of the region. The topography is flat to slightly undulating with only minor stream incision. There are heavy textured sediments in the lower sub-level, and medium to light textured sediments in a higher sub-level.

The middle terrace is fairly widespread throughout the northeast, but is most extensive in the northern part. The topography is undulating to rolling. The sediments of the middle terrace show a distinct lithologic break with a sandy upper part and a clayey lower part often accompanied with laterite gravels. In some places, the upper sandy parts have been partly or wholly eroded away bearing the lower clayey sediments at or near the surface.

The oldest or high terrace exists now only as small remnants or islands scattered throughout the region. The sediments of this terrace are generally sandy clay loam in texture and show a typical red colour. Gravels usually occur at great depth.

Apart from these terraces, colluvial fans are also an important feature of the northeastern landscape. These fans occur skirting the hilly areas and the escarpments on the different terraces.

3. Soil Types

On the flood plains alluvial and alluvial hydromorphic soils prevail. On the lower terraces, low humic gley with lateritic concretions and sheet

laterite dominate in lower strata, followed by gray podzolic and red-yellow podzolic soils occur to the middle terrace. The high terrace consists of red-yellow latosols. To a minor extent, grumosols, red-brown earth and rendzinas are reported.

Alluvial soils are characterized by generally poor drainage in the lower levels and a moderate fertility for rice production with high content of calcium, magnesium and potassium, but low content of phosphorus, organic matter and nitrogen. Acidity ranges from moderate to slight but is somewhat higher in swampy areas.

Low humic gley soils often have poor drainage, low content of organic matter, nitrogen and phosphorus but medium to high content of calcium and magnesium. Acidity is moderate to strong. Groundwater laterite occurs in some of these soils. Saline soils may be associated with some low humic gley soils, as a result of large rock salt deposits underneath the Plateau. Most of the low humic gley soils are continuously planted to paddy depending on rainwater alone.

Gray podzolic soils are poor in weatherable minerals, have a high content of quartz and more organic matter than other soils. They dominate in the areas which are not used for paddy land. Most of the original Dipterocarp forest has been cut for growing Kenaf. Much of the Kenaf land has already reverted to poor shrub forest or changed into land for cassava.

Red-yellow podzolic soils contain laterite concretions and are rarely cultivated since they are very susceptible to erosion which makes the concretionary layer exposed. Once this has taken place further cultivation is difficult. In addition, these soils have usually moderate acidity on the surface and they are strongly acid in the subsoil. Except for virgin

soils, the organic matter content is low and there is a lack of calcium and phosphorus.

Red-yellow latosols are often planted to upland crops such as kenaf and, in some parts, cotton. They are low in calcium, magnesium, potassium, phosphorus and organic matter, resulting in low yields especially when accompanied with water deficiency. (Fig. 6)

Approximate Correlation between the Great Soil Groups in Northeast Thailand and the Great Groups of U.S. Soil Taxonomy

Alluvial soils (Ustifluvents, Tropaquepts and Fluvaquents)

Low humic gley soil (Paleaquults, Plinthaquults, and Tropaqualfs)

Low humic gley, Gray podzolic and Red-yellow podzolic soils with laterite (Paleaquults, Paleustults, Paleudults, Dystropepts, Plinthaquults and Plinthustults)

Gray podzolic soils (Paleustults, Paleudults, Tropudults, Dystropepts)

Red-yellow podzolic soils (Paleustults, Paleudults, Haplustults, Plinthustults and Tropudults)

Red-yellow latosols (Paleustults, Haplustults and Palehumults)

4. Soil Distribution in the Northeast Expressed in Terms of "Soil Taxonomy"

LOWLANDS of the Northeast occupy an area of about 5.03 million hectares. The major soils of the lowlands consist of 3.43 million ha of Loamy Paleaquults, 0.18 million ha of Loamy Natraqualfs and a small area of Skeletal texture of Plinthaquults and Paleaquults. The rest of the lowlands area which covers about 1.32 million ha is Clayey texture soil of Ultisols and Inceptisols. Large parts of the recent alluvial plains are flooded by river water during the peak of the rainy season and there is occasional damage by flash floods. Many parts

of the recent alluvial flood plains and some parts of the low terraces, soils of which are Loamy Natraqualfs, have saline ground water especially during the dry season causing high salt content in the surface soil, and are hence a hazard to the crop grown as well.

UPLAND SOILS of the Northeast region cover an area of about 12.47 million hectares. The major soils are 2.56 million ha of skeletal texture soil of Ultisols, 6.40 million ha of loamy texture Ultisols, 0.40 million ha of Alfisols with skeletal texture, 0.35 million ha of Loamy Dystropepts, 0.49 million ha of Sandy Quartzipsamment and 0.30 million ha of Clayey Paleustults. The rest of the land area is slope complex and a small area of other soil orders.

5. Soil Fertility

Soil fertility is moderate to low on nearly all soils of both uplands and lowlands. Ultisol soils occupy major part of both the lowland and upland areas. They are more highly weathered and acidic than the Alfisols but generally are not so acid as Spodosols. Coarse texture soils prevail in the Northeast; these soils are poorer in fertility than the fine texture soil of the same great group. Because of the low waterholding capacity of these soils, serious crop damage due to drought frequently occurs in the Northeast. These coarse textured soils are highly susceptible to leaching under the high intensity of rainfall during the wet season; this could be an important factor in determining the efficiency of fertilizer use. These soils are also low in organic matter content and soil fertility depends largely on the amount of organic matter present in the soils. The beneficial effects of organic matter consist in supplying most of the nitrogen and sulfur to crops, maintaining cation exchange capacity, blocking phosphorus fixation sites, improving structure in poorly aggregated soils, and the

formation of complexes with micronutrients. Many of the upland soils of the Northeast are deficient in phosphorus and sulfur. The present low fertility of major soils, in terms of organic matter, nitrogen, phosphorus, sulfur and other plant nutrients, is likely to become even more pronounced because of increasing cropping intensities and introduction of new cultivars with higher yield potential but higher nutrient requirements.

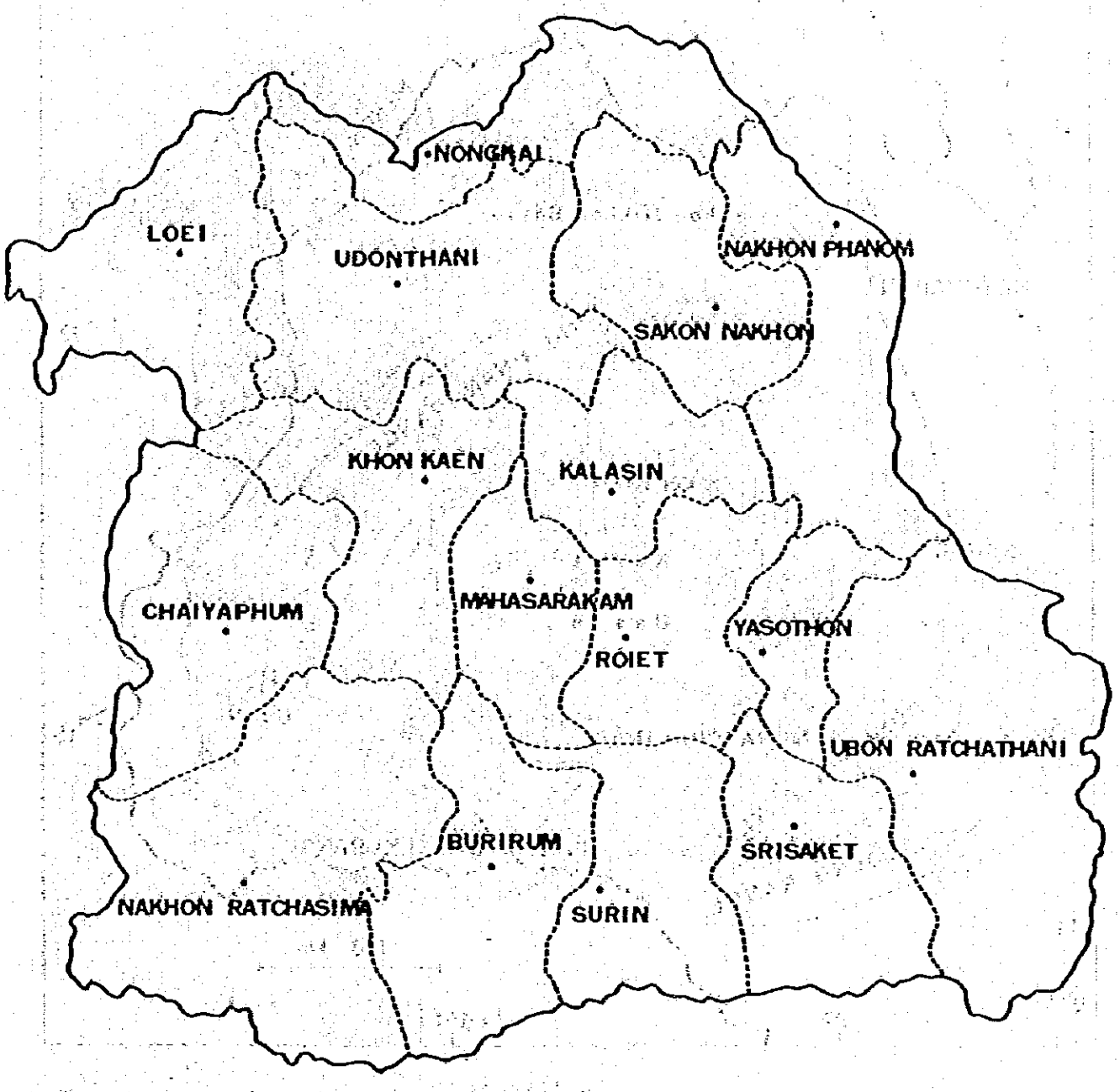


Fig. 1 The Northeast Region showing Changwat (provincial) boundaries.

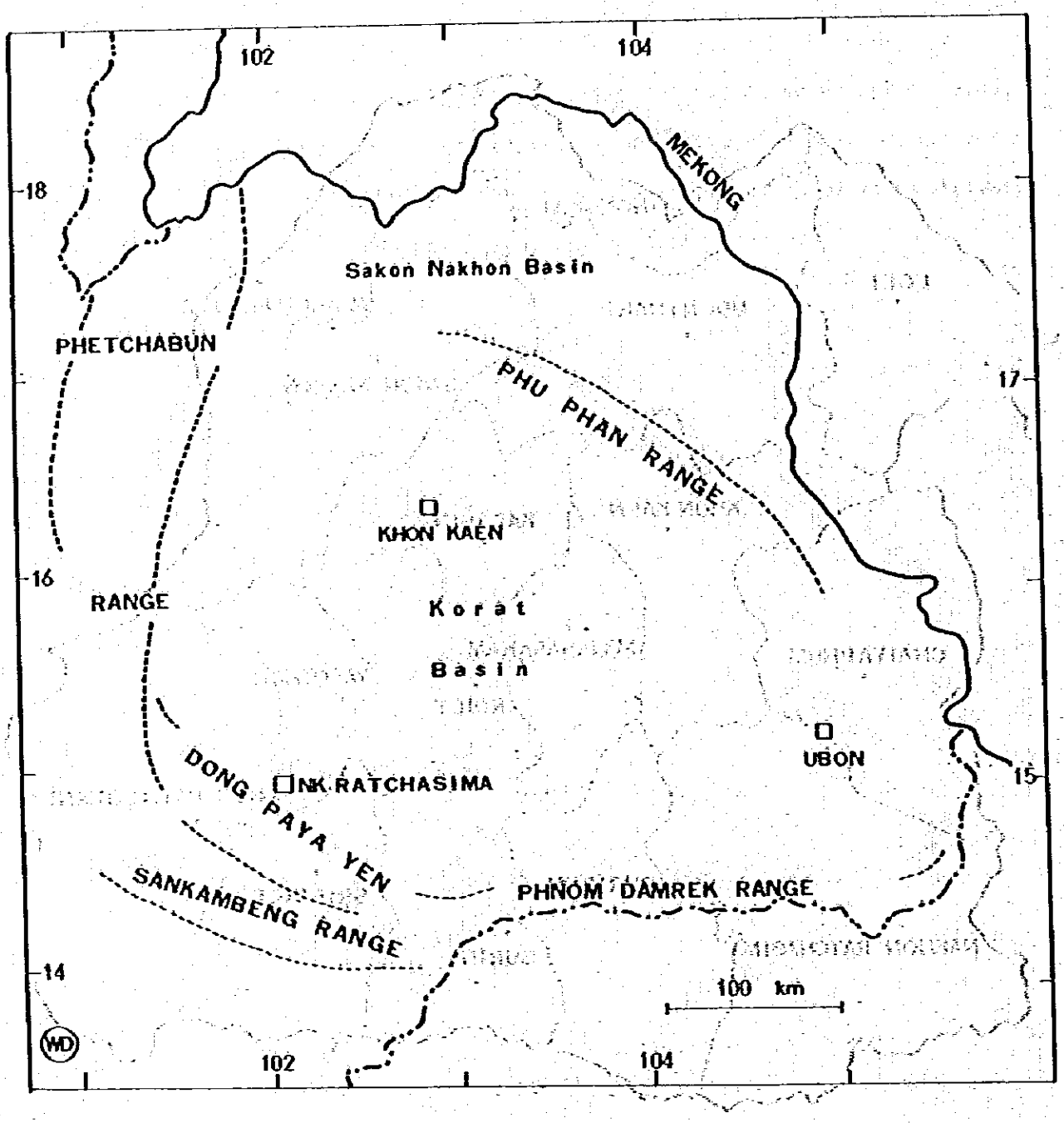


Fig. 2 The spatial division of northeastern Thailand. (Ref. 14)

Hilly

Undulating
(Miniwatershed)

Flood and non-flood plains

Fig. 3 Land form map of the Northeast (Ref. 13 Original source; Department of Land Development, 1972).

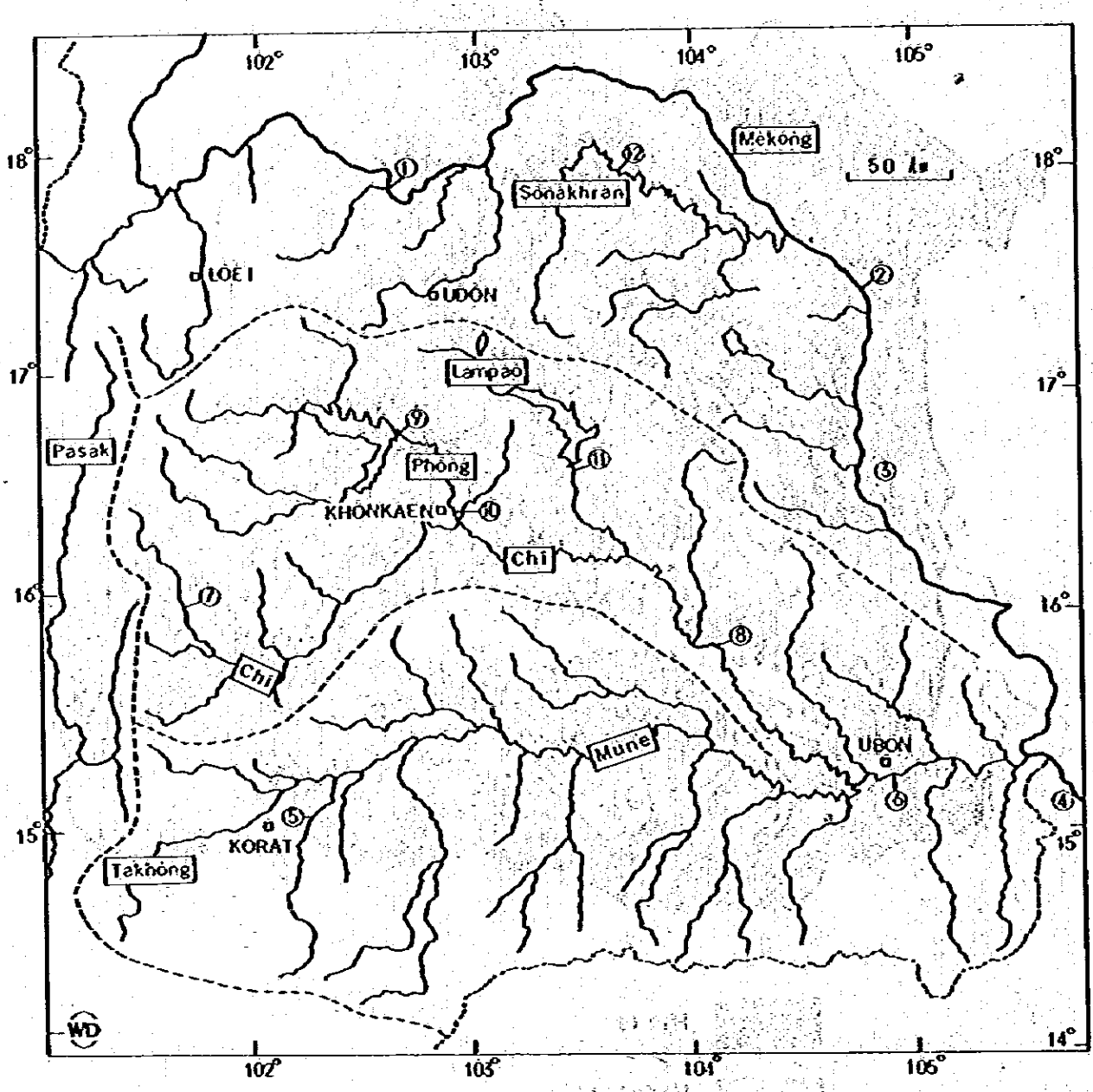
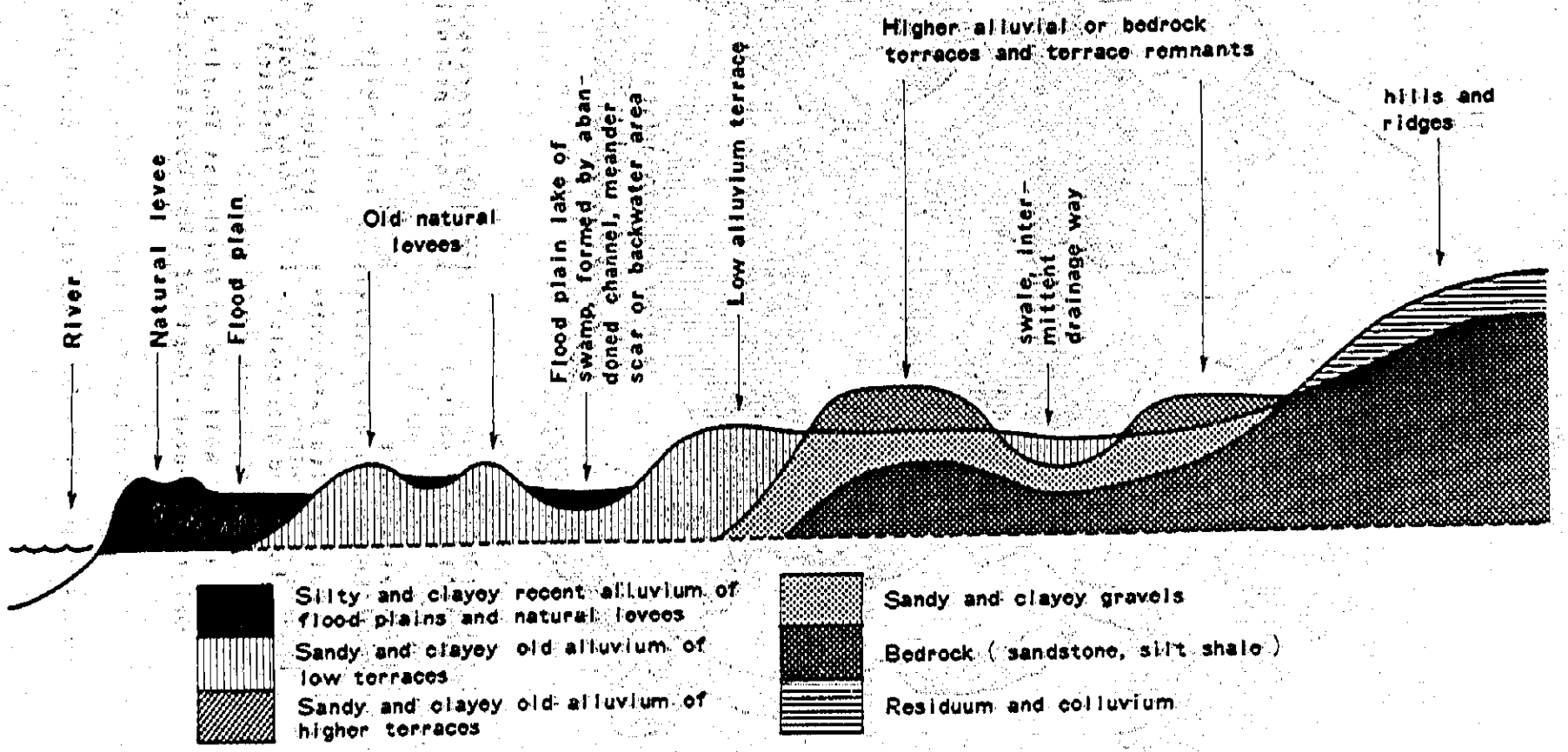
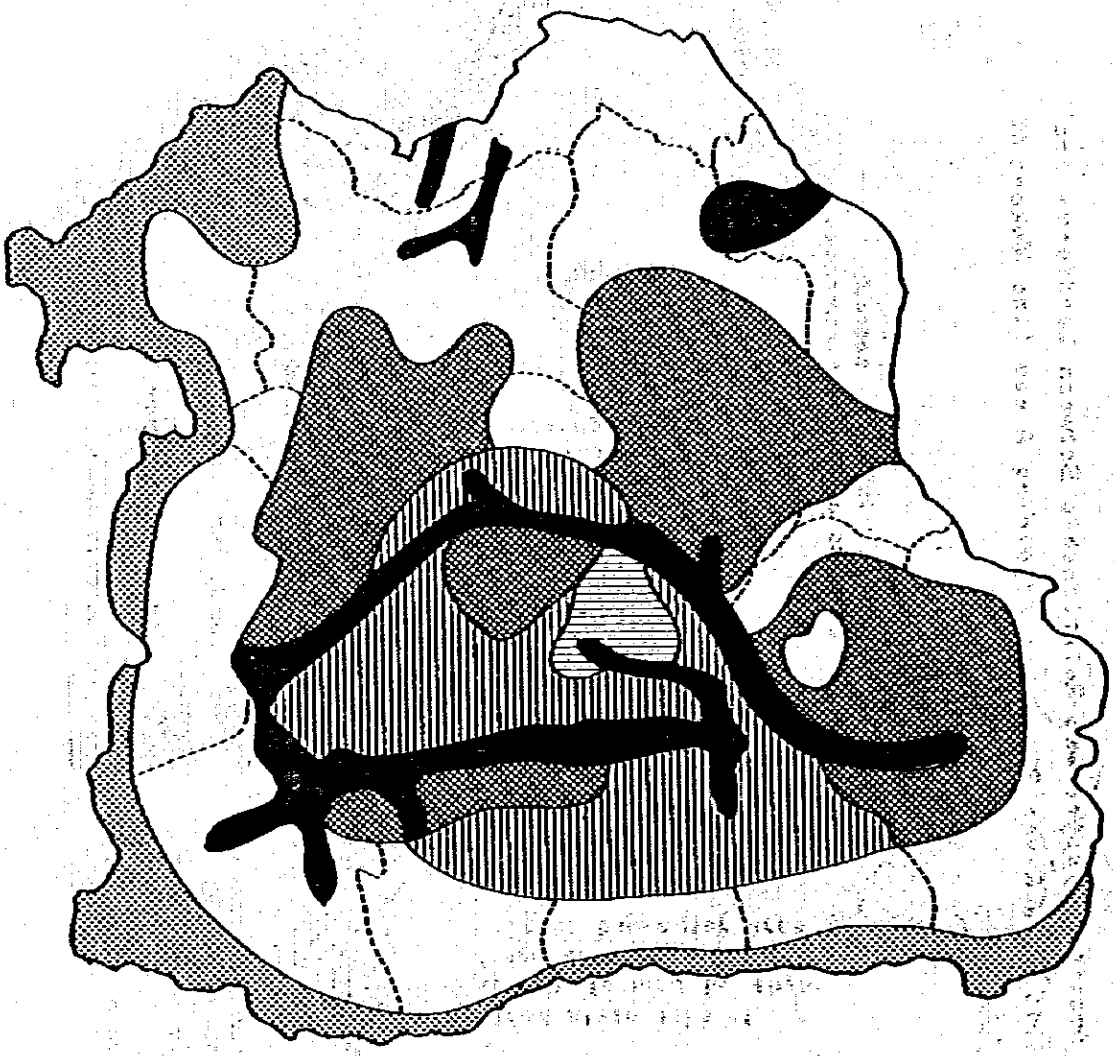


Fig. 4 Hydrological Map of Northeast Thailand (Ref. 14)

Fig. 5 Idealized Cross-Section Illustrating Relationship Between Landforms and Substrate Materials of a River Plain and Adjoining Areas (the Mekong at Pa Mong). (Ref. 14)





Tropaqupts (Alluvial soils)

Dystropepts (gray podzolic soils)

Paleaquults (Low humic gley soils)

Hill soils

Paleustults/Paleaquults (gray podzolic/ Low humic gley soils)

Paleustults and Plinthustults (gray podzolic soils with laterite)

Fig. 6 Simplified soil map of Northeast Thailand (Ref. 13) Original source: Dept. of Land Development. 1979).

Climate in the Northeast

The climate of Thailand is largely influenced by three major air streams of different characteristics, the southwest monsoon, northeast monsoon and southerly wind. In addition, cyclonic rain and cyclones have an influence on the weather of the country. (Fig. 7).

Distribution of rainfall is mostly bi-modal, starting with the arrival of the southwest monsoon, originating over the Indian Ocean and coming into Thailand about the middle of May, resulting in the first rains of the Southern region. Then this monsoon trough gradually moves up towards the north passing through the country into the southern part of China, from the middle of July to the end of August. As a result of this phenomenon, dry spells which last at least 2-3 weeks occur in the country affecting crop cultivation in the rain-fed areas. The monsoon trough afterward turns back into the country again from August to the beginning of October. Rainfalls pick up intensity during September and gradually decrease to no rain, signaling the end of the rainy season. Ceasing in the Northern and Northeastern regions in early October, rainfalls move down through the Central region, the eastern region and back to the South creating a period of heavy rain in those places.

In the meantime, the Northeast monsoon, dry and cold and originating on the mainland, begins to move into Thailand, creating the country's cool season. This season lasts from October until the beginning of February.

The southerly wind starts from the beginning of February to the middle of May. This is a kind of wind originating in the Tropical North Pacific air mass blowing from south to north.

Cyclone/typhoon and accompanying rain, which influence the weather of the country, originate mainly in the South China Sea and move eastward

along the monsoon trough. The truck, directed to the north of the country or southern part of China in July, moves down to the Northern, Northeastern and Central regions during September and October, and the Southern region at the end of October to the end of November.

The climatic conditions of the Northeast are determined by the factors mentioned above, but its specific topography modifies the picture. Unlike the Central Plain which is open towards the south, the Korat Plateau is clearly locked off in the west and the south, and beyond the Mekhon, also in the northeast, by more or less important ranges (Fig. 2). Therefore, the Northeast is by far more continental than all the other regions of Thailand. The Phetchabun and Phnom Damrek Ranges form a clear barrier against the southwest monsoon creating a rain shadow area in the western part of the region. The Annam Cordillera beyonds the Mekong, on the contrary, causes heavy precipitations which still influence the northern and northeastern part of the Korat Plateau. At the time of the northeastern winter monsoon the picture is reversed; the Annam Cordillera causes a rain shadow on the region whereas the western and mainly southern border mountains force some additional rainfall out of the wind. The average monthly rainfall in each province and isohyets for mean annual rainfall are shown in Table 1 and Fig. 9 , respectively.

The annual average rainfall in the Northeast amounts to 1426.5 mm, out of which around 20% falls in September, the month of heaviest rain in a year, and another 60% May to August. Judging from the above figures, the rainfall pattern in the Northeast as a whole does not seem bad. However, problems exist in its year to year fluctuations both in amount and locality. The following facts, for example, should be taken into account.

On the basis of the annual rainfall data compiled in Table 1 and Fig. 9 , there seem to be four distinct rainfall areas in the Northeast.

a) Western mountains and foothills (Loei, Chaiyaphum, Nakhon Ratchasima), the dryest area; b) southern mountains and foothills (Si Sa Ket, Surin, Buri Ram), a slightly less dry area; c) the Mekong Valley (Nong Khai, Nakhon Phanom, Udon Thani, Sakhon Nakhon, Ubon Ratchathani); and d) the area consiting of provinces (Maha Sarakam, Khon Kaen, Kalasin, Roi Et, Yasothon) which neither fit together nor fit clearly into the neigbouring areas.

Fig.10 shows the total number of drought days during the major crop season, May to October, based on records of 20 years (1950-1970)[20]. Regarding stability of crop production, a study on variation of rice production in each province based on the statistical data for 14 to 31 years revealed that the variation coefficients scored very high in Buri Ram, Surin, Nakhon Ratchasima, Maha Sarakam, Khon Kaen, Roi Et and Loei (Table 2)[30].

Table 3, which was adapted from the study of the Asian Institute of Technology (AIT) in 1980 [2], indicated the minimum rainfall that could be expected at different probability levels for three different time periods (10 days, 15 days and monthly) for six selected meteorological stations. Out of them, Loei and Nakhon Ratchasima were selected to represent dry areas; Nakhon Phanom and Ubon Ratchathani rainy areas; and Khon Kaen and Roi Et the intermediate. As shown in Table 4, annual potential evapotranspiration in the Northeast ranges from 900 mm to 1350 mm (roughly 100 mm per month). Assuming water holding capacity of soils as 50 mm, monthly rainfall of 100 mm would be the minimum requirement to ensure normal plant growth. However, probabilities of this amount of rainfall in major growing seasons at those sites are quite low except for August and September or rainy areas like Nakhon Phanom and Ubon Ratchatani as shown in Table 3.

Air temperature is highest in April and lowest in January but it does not cause any problem to plant growth. Relative humidity reaches a

minimum of 60% in March and rises to a maximum of about 80% in August-September.

Table 1. Monthly and Annual Normals of Rainfall in the Northeast Thailand (30 years' average 1951 - 1980) in mm

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Nong Khai	5.9	8.6	28.5	97.2	247.2	294.5	248.8	333.1	301.1	51.2	8.2	3.5	1627.8
Loei	5.8	16.4	47.2	87.6	195.3	174.7	159.0	193.0	247.0	94.8	11.7	3.7	1236.2
Udon Thani	7.2	20.3	39.0	80.0	217.9	240.7	228.4	289.6	282.9	79.7	7.4	2.6	1495.7
Nakhon Phanom	7.1	18.9	43.9	100.2	239.7	480.4	422.6	592.6	315.5	52.2	4.7	1.1	2278.9
Sakhon Nakhon	7.0	15.6	41.7	84.9	229.6	260.8	208.1	319.2	260.4	62.2	5.7	2.5	1497.7
Mukdaharn	4.2	15.7	39.7	86.6	181.9	275.3	243.6	313.7	294.6	63.3	3.8	1.1	1523.5
Khon Kaen	7.7	15.4	34.2	62.7	171.8	180.8	156.5	188.3	276.9	86.0	13.5	2.9	1196.7
Roi Et	3.4	15.2	29.4	88.7	193.2	193.0	206.3	255.3	325.9	87.5	9.2	1.1	1408.2
Ubon Ratchathani	0.7	8.5	43.3	78.7	206.3	252.7	282.5	322.3	279.0	91.5	20.3	1.8	1587.6
Surin	2.5	9.2	28.1	88.2	182.2	160.2	189.3	200.5	282.0	131.9	22.4	1.7	1298.2
Nakhon Ratchasima	3.5	22.9	55.2	70.0	157.6	116.2	131.0	126.9	263.3	157.7	30.0	3.1	1137.4
Chaiyaphum	3.8	17.5	50.6	84.0	164.4	147.1	153.4	146.2	310.0	121.9	15.6	3.5	1218.0
Kalasin	6.3	17.0	29.8	58.8	194.9	233.2	226.9	247.2	285.8	63.7	4.3	2.3	1370.2
Maha Sarakham	4.8	13.6	39.6	69.1	188.8	189.8	179.2	211.6	292.5	70.1	6.4	2.5	1268.0
Yasothon	5.1	14.7	26.9	66.3	196.2	194.2	223.6	262.7	312.5	83.7	11.7	0.4	1398.0
Buri Rum	3.0	11.7	33.9	69.2	164.6	175.4	155.0	177.9	303.9	131.6	24.6	1.2	1252.0
Si Sa Ket	0.2	7.2	23.9	73.6	180.8	220.1	217.7	263.6	285.8	159.9	23.1	0.8	1456.7
Regional Average	4.2	14.6	37.4	79.2	194.8	222.9	213.6	261.4	289.4	93.5	13.1	2.0	1426.5

Source: Meteorological Department, 1982; Monthly and Annual Rainfall of Thailand 30-year Period (1951 - 1980)

Table 2. Variation Coefficients of Rice Production in Provinces of the Northeast (Ref. 30)

	Period of record	Rice production	Yield per unit area	Ratio of planted area	Ratio of harvested area
Buri Ram	1951 - 68	49	21	26	14
Surin	1951 - 68	45	24	26	22
Nakhon Ratchasima	1937 - 68	42	17	26	15
Maha Sarakham	1951 - 68	51	31	27	16
Khon Kaen	1937 - 68	36	18	19	13
Roi Et	1951 - 68	30	15	19	7
Loei	1954 - 68	27	14	17	5
Nakhon Phanom	1953 - 68	15	13	3	7
Kalasin	1951 - 68	20	7	17	6
Ubon Ratchathani	1946 - 68	17	11	8	4
Sakhon Nakhon	1951 - 68	17	8	2	9
Udon Thani	1947 - 68	22	20	7	7

Table 3. Ten Days, Fifteen Days and Monthly Precipitation Data in mm at Selected Meteorological Stations

Khon Kaen (Record Length : 26 Years)

Month	10 Days Precipitation					15 Days Precipitation					Monthly Precipitation				
	Probability Smaller than					Probability Smaller than					Probability Smaller than				
	10	20	30	40	50	10	20	30	40	50	10	20	30	40	50
Jan	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.3	0.7	1.5	3.0
Feb	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.4	1.3	2.6	4.7
Mar	0.0	0.0	0.0	0.0	0.0	0.2	0.5	1.1	1.9	3.2	4.7	8.2	12.2	16.3	21.4
Apr	0.1	0.2	0.5	1.0	1.6	0.5	1.3	2.3	3.9	5.5	17.1	25.7	32.7	40.4	48.2
May	0.5	1.2	2.5	3.7	5.5	5.4	9.7	14.0	18.8	23.6	52.0	71.1	90.2	107.4	126.6
Jun	0.5	1.4	2.7	4.3	6.7	6.1	9.9	14.9	19.9	26.6	66.1	86.2	106.6	124.6	144.8
Jul	0.8	1.8	2.9	4.3	6.1	8.3	12.4	17.1	20.8	25.4	70.2	88.2	101.7	116.4	129.9
Aug	5.5	8.2	10.7	13.1	15.8	19.0	23.7	28.9	34.1	39.3	118.2	137.7	150.7	165.9	181.1
Sep	6.9	10.0	14.8	18.2	22.1	19.7	30.6	40.6	50.5	60.4	141.1	170.3	195.3	220.3	251.5
Oct	0.1	0.2	0.3	0.7	1.1	0.2	0.6	1.1	2.2	3.6	16.9	27.0	37.1	48.2	60.2
Nov	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.6	1.6	3.2	5.9
Dec	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.4	1.0	1.8

Loei (Record Length : 22 Years)

Month	10 Days Precipitation					15 Days Precipitation					Monthly Precipitation				
	Probability Smaller than					Probability Smaller than					Probability Smaller than				
	10	20	30	40	50	10	20	30	40	50	10	20	30	40	50
Jan	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.2	0.3	0.3	0.2	0.5	1.3	2.1	3.6
Feb	0.0	0.1	0.3	0.8	2.6	0.1	0.1	0.2	0.3	0.5	0.4	1.2	2.2	3.2	4.8
Mar	0.1	0.2	0.4	0.8	1.8	0.2	0.7	1.1	1.8	2.6	9.1	14.6	20.1	25.5	31.9
Apr	0.3	0.8	1.6	2.6	3.9	1.1	2.9	5.0	7.5	10.7	22.2	32.8	42.5	51.8	62.0
May	2.2	4.0	6.1	8.3	11.1	8.3	13.3	17.7	22.7	27.7	55.3	77.8	96.2	114.6	133.0
Jun	2.2	3.8	5.5	7.2	9.0	8.5	12.8	16.2	20.5	24.8	54.7	72.9	91.1	109.3	127.5
Jul	0.6	1.3	2.2	3.2	4.6	3.6	6.7	9.3	12.4	16.0	47.9	63.8	76.2	88.6	101.0
Aug	3.7	6.2	8.7	11.6	14.5	12.6	18.9	25.2	31.8	37.0	75.2	99.6	117.3	135.0	154.9
Sep	4.6	9.2	14.4	19.6	26.0	25.6	35.8	43.4	52.0	60.5	86.1	116.7	144.5	169.5	197.2
Oct	0.1	0.3	0.6	1.3	2.3	0.4	1.4	2.6	4.9	7.6	17.7	29.9	41.0	55.4	66.4
Nov	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.2	0.3	0.2	0.8	1.7	2.8	4.5
Dec	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.6	1.3	2.9

Nakhon Phanom (Record Length : 26 Years)

Month	10 Days Precipitation					15 Days Precipitation					Monthly Precipitation				
	Probability Smaller than					Probability Smaller than					Probability Smaller than				
	10	20	30	40	50	10	20	30	40	50	10	20	30	40	50
Jan	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.6	1.1	2.0	3.2
Feb	0.0	0.0	0.0	0.0	0.0	0.2	0.3	0.6	0.8	1.2	0.7	1.8	3.7	5.9	8.8
Mar	0.0	0.1	0.2	0.5	0.9	0.2	0.7	1.3	2.1	3.2	8.6	14.1	19.6	25.7	32.4
Apr	0.3	0.8	1.7	2.5	3.8	4.7	8.3	11.8	14.7	18.3	30.8	43.6	54.6	65.6	76.6
May	6.1	9.7	12.7	16.2	20.2	21.2	27.7	33.4	39.1	45.6	144.1	163.4	182.7	202.0	221.3
Jun	18.6	27.7	34.7	42.8	50.9	41.8	59.4	77.0	92.5	110.1	214.0	271.1	323.0	369.8	416.5
Jul	17.6	24.6	31.0	37.3	43.7	55.3	69.5	81.9	94.3	103.7	269.6	298.1	326.7	355.2	383.7
Aug	16.5	26.0	34.5	44.0	54.5	61.9	83.1	106.4	129.6	155.0	323.8	386.2	438.1	490.1	547.2
Sep	2.0	5.4	8.7	14.1	20.1	18.3	30.0	40.4	50.8	63.8	158.9	199.9	230.7	261.4	294.8
Oct	0.1	0.2	0.6	1.7	3.9	0.1	0.5	1.0	1.9	3.2	8.7	14.5	20.2	26.0	33.2
Nov	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.3	0.6	0.2	0.5	1.0	1.6	2.4
Dec	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.6	0.7	0.7	0.7

Nakhon Ratchasima (Record Length : 26 Years)

Month	10 Days Precipitation					15 Days Precipitation					Monthly Precipitation				
	Probability Smaller than					Probability Smaller than					Probability Smaller than				
	10	20	30	40	50	10	20	30	40	50	10	20	30	40	50
Jan	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.5	1.0	1.8
Feb	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.3	0.6	1.0	1.0	2.5	5.0	7.5	11.0
Mar	0.0	0.0	0.0	0.0	0.0	0.2	0.5	1.3	2.1	3.2	11.7	18.3	24.9	31.5	38.1
Apr	0.1	0.3	0.7	1.0	1.6	1.6	2.9	4.1	5.5	7.1	25.3	34.8	43.4	52.1	60.7
May	1.8	3.6	5.4	7.7	10.4	11.2	17.6	23.3	29.0	34.6	62.3	83.7	100.6	117.5	135.9
Jun	1.2	2.4	3.7	5.1	6.6	4.9	8.4	12.0	16.0	20.1	59.1	74.8	85.3	98.9	113.5
Jul	1.4	2.7	4.1	5.6	7.3	9.1	13.4	17.7	21.6	25.9	69.5	84.1	95.3	106.5	118.9
Aug	1.7	3.0	4.5	6.5	8.2	8.5	12.2	16.0	20.1	24.6	63.1	77.3	91.4	105.6	119.7
Sep	6.9	10.7	14.5	18.3	22.1	30.2	39.1	48.0	56.9	65.8	142.3	169.7	192.1	214.5	234.4
Oct	0.2	0.5	0.9	1.5	2.1	1.2	2.7	4.6	6.4	9.1	65.5	84.5	102.0	119.5	138.4
Nov	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.4	0.7	0.6	2.0	3.9	6.5	10.0
Dec	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.5	1.3	2.1

Roi Et (Record Length : 26 Years)

Month	10 Days Precipitation					15 Days Precipitation					Monthly Precipitation				
	Probability Smaller than					Probability Smaller than					Probability Smaller than				
	10	20	30	40	50	10	20	30	40	50	10	20	30	40	50
Jan	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.4	0.8	1.4
Feb	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.3	0.6	1.5	0.3	1.0	2.1	3.9	6.3
Mar	0.0	0.0	0.0	0.0	0.0	0.1	0.3	0.6	1.0	1.6	2.1	5.0	7.8	10.6	14.8
Apr	0.2	0.5	0.9	1.4	2.1	0.6	1.5	2.9	4.6	7.2	24.7	36.4	45.3	54.3	64.1
May	1.5	2.9	5.0	7.1	10.3	5.7	9.8	14.9	21.0	27.1	75.9	98.9	117.3	138.1	158.8
Jun	2.6	4.8	7.4	9.9	12.8	12.6	18.3	24.1	29.1	34.0	114.0	132.5	149.5	166.6	185.0
Jul	3.1	5.1	7.0	9.0	11.3	10.2	16.3	22.3	28.4	35.2	115.0	138.5	154.1	172.9	193.3
Aug	5.2	8.8	12.4	16.1	20.7	13.4	22.9	31.3	40.8	51.5	114.5	148.9	179.1	204.9	232.8
Sep	8.1	13.7	18.7	24.3	30.0	27.0	38.4	51.0	61.5	71.9	170.1	201.9	231.4	258.6	285.9
Oct	0.1	0.2	0.4	0.8	1.4	0.4	1.0	1.7	2.9	4.4	21.3	31.7	43.4	55.0	66.6
Nov	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.5	1.2	2.4	4.0
Dec	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.3	0.4	0.5	0.7

Ubon Ratchathani (Record Length : 26 Years)

Month	10 Days Precipitation					15 Days Precipitation					Monthly Precipitation				
	Probability Smaller than					Probability Smaller than					Probability Smaller than				
	10	20	30	40	50	10	20	30	40	50	10	20	30	40	50
Jan	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.4	0.6
Feb	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.2	0.2	0.2	0.2	0.5	1.1	2.1	3.4
Mar	0.1	0.2	0.6	1.6	4.6	0.1	0.4	1.0	2.2	4.0	1.5	4.8	8.6	14.3	21.9
Apr	0.1	0.3	0.5	0.9	1.4	1.0	2.2	3.9	5.6	8.2	24.2	34.9	44.5	55.2	67.0
May	2.1	4.5	7.0	10.0	13.5	7.3	12.3	18.3	24.5	31.5	78.8	101.6	124.4	150.4	176.4
Jun	7.2	11.4	14.8	18.6	22.8	22.5	32.3	39.2	46.2	53.9	129.0	154.0	174.8	193.6	214.4
Jul	9.6	12.8	16.5	20.5	24.6	34.0	44.9	54.5	63.2	72.7	156.4	185.4	212.7	238.1	265.3
Aug	15.6	22.3	26.5	31.1	36.2	35.9	48.7	58.9	69.1	81.9	174.8	205.2	233.2	261.2	291.6
Sep	11.0	16.2	20.5	24.8	29.6	34.5	44.6	53.3	63.4	71.3	177.9	201.6	225.4	247.3	271.0
Oct	0.1	0.3	0.4	0.7	0.9	0.3	0.7	1.5	2.6	4.0	20.7	33.2	44.3	55.4	67.9
Nov	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.3	0.6	1.1	2.7	4.6	7.2	10.5
Dec	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.4	0.6	1.0

Figures encircled by dashed lines indicate precipitation more than 100 mm per month or its equivalents.
In case of 15 days precipitation, 50 mm will be equivalent; similarly, 10 days 30 mm approximately.

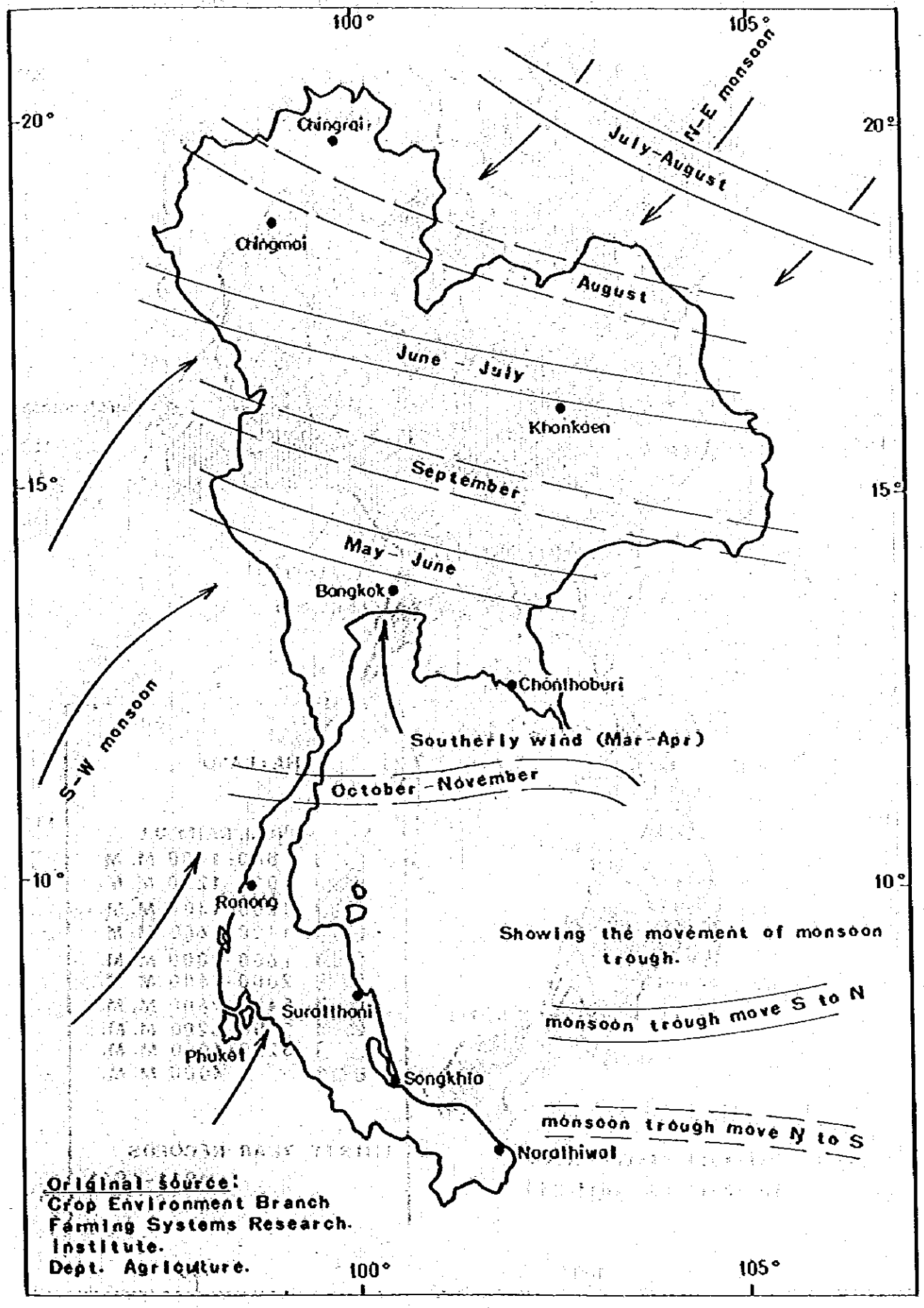
Table 4. Estimated Potential Evapotranspiration in the Northeast (Ref. 9)

Unit : mm

Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
Sakhon Nakhon	117	119	154	132	102	90	92	81	81	101	112	110	1291
Roi Et	77	77	102	108	95	86	75	76	70	76	77	70	989
Ubon Ratchathani	105	112	145	130	110	99	112	99	91	117	117	115	1352
Surin	103	108	130	138	105	102	100	85	80	95	100	100	1246
Loei	73	76	96	99	86	79	80	72	60	70	67	69	927
Nakhon Ratchasima	91	92	116	116	104	108	104	100	81	84	81	85	1162
Khon Kaen	101	106	132	135	120	102	110	100	89	102	103	104	1304

Note: Potential evapotranspiration was estimated through multiplying panevaporation (class A pan of 120 cm in diameter) by 0.6.
The period of record was 1965 - 1970.

Fig. 7 Wind direction and their periods of influence in the Kingdom of Thailand. (Ref. 29)



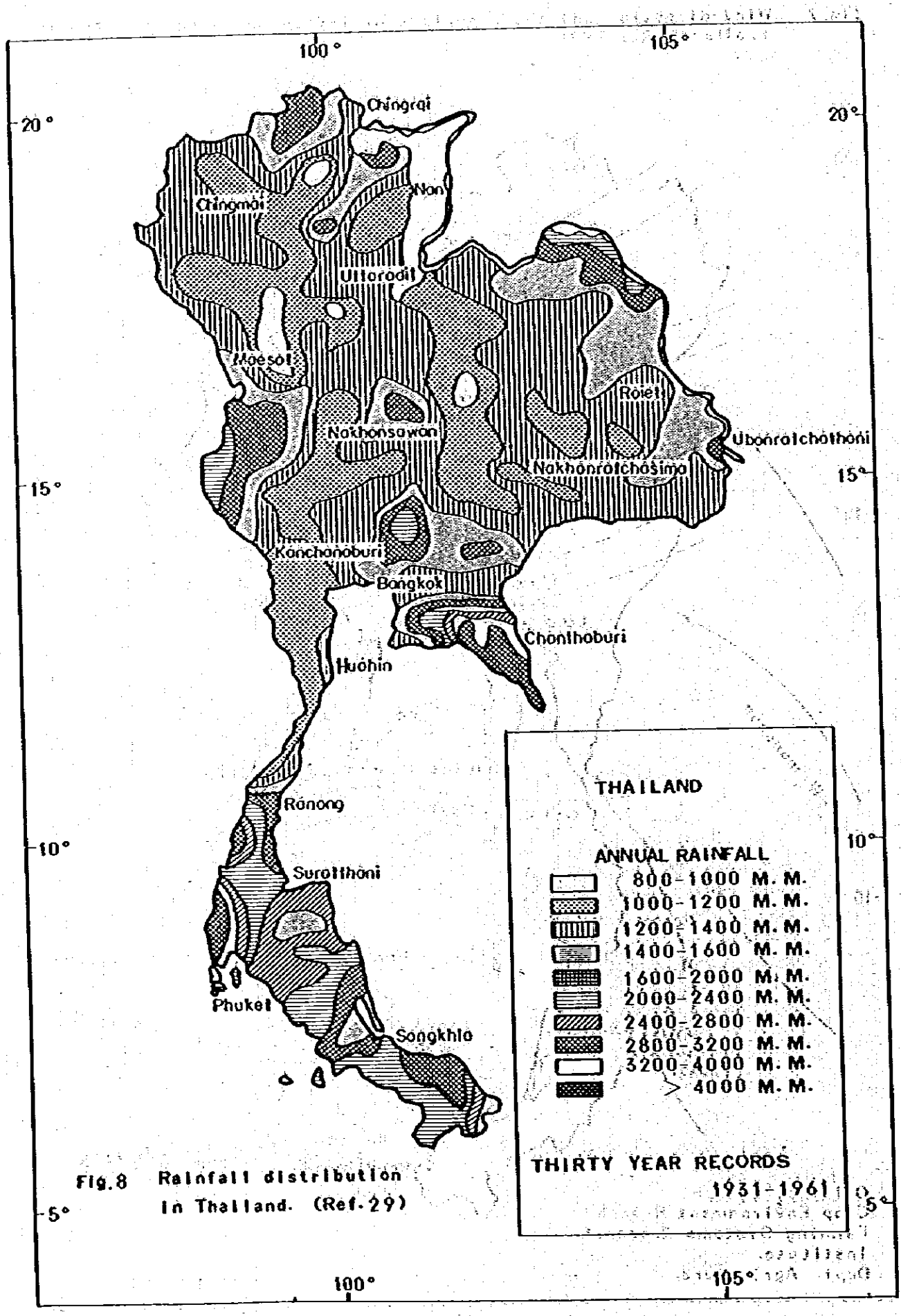


Fig. 8 Rainfall distribution in Thailand. (Ref. 29)

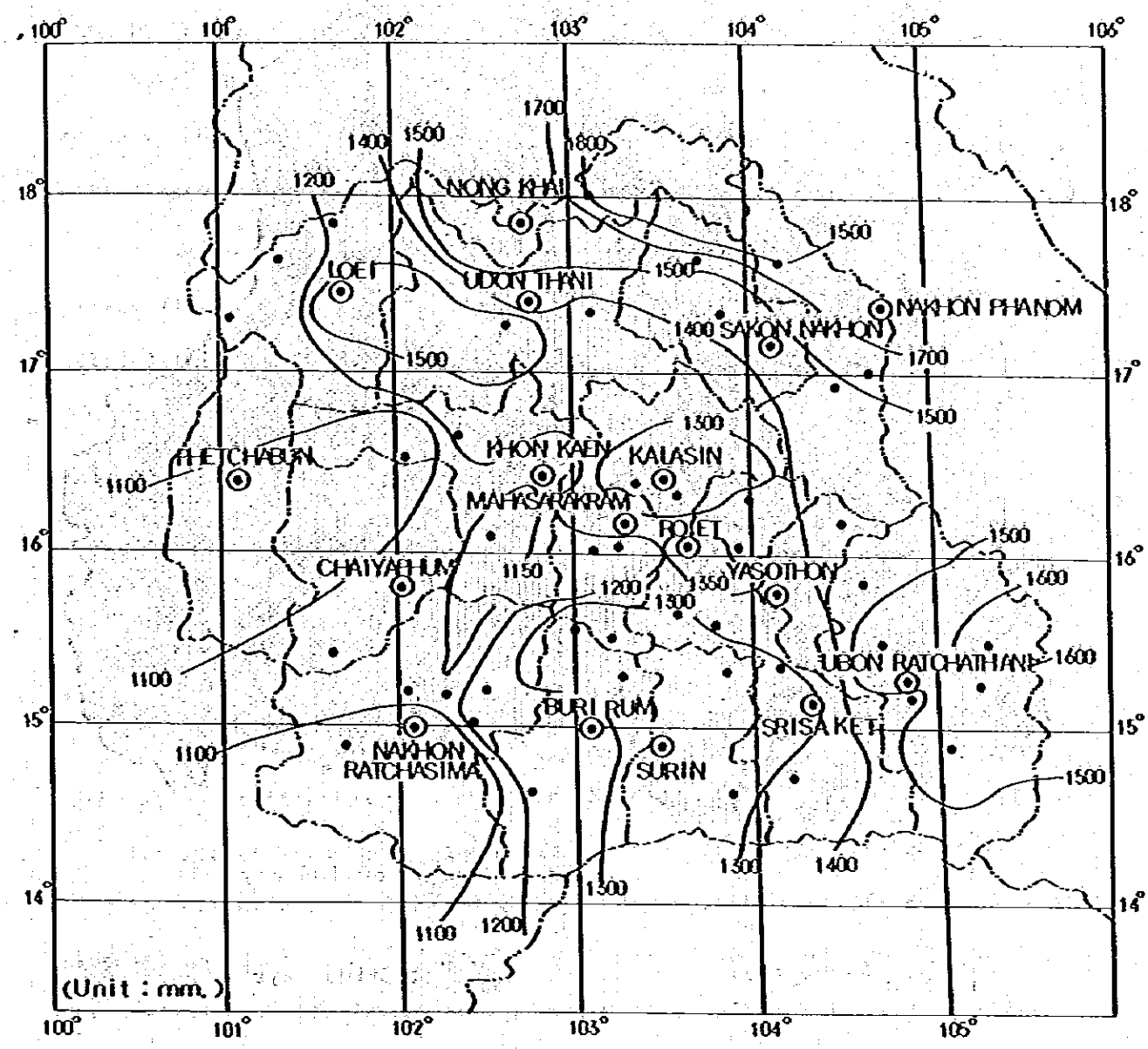


Fig-9 Isohyets for Mean Annual Rainfall (Ref. 1)

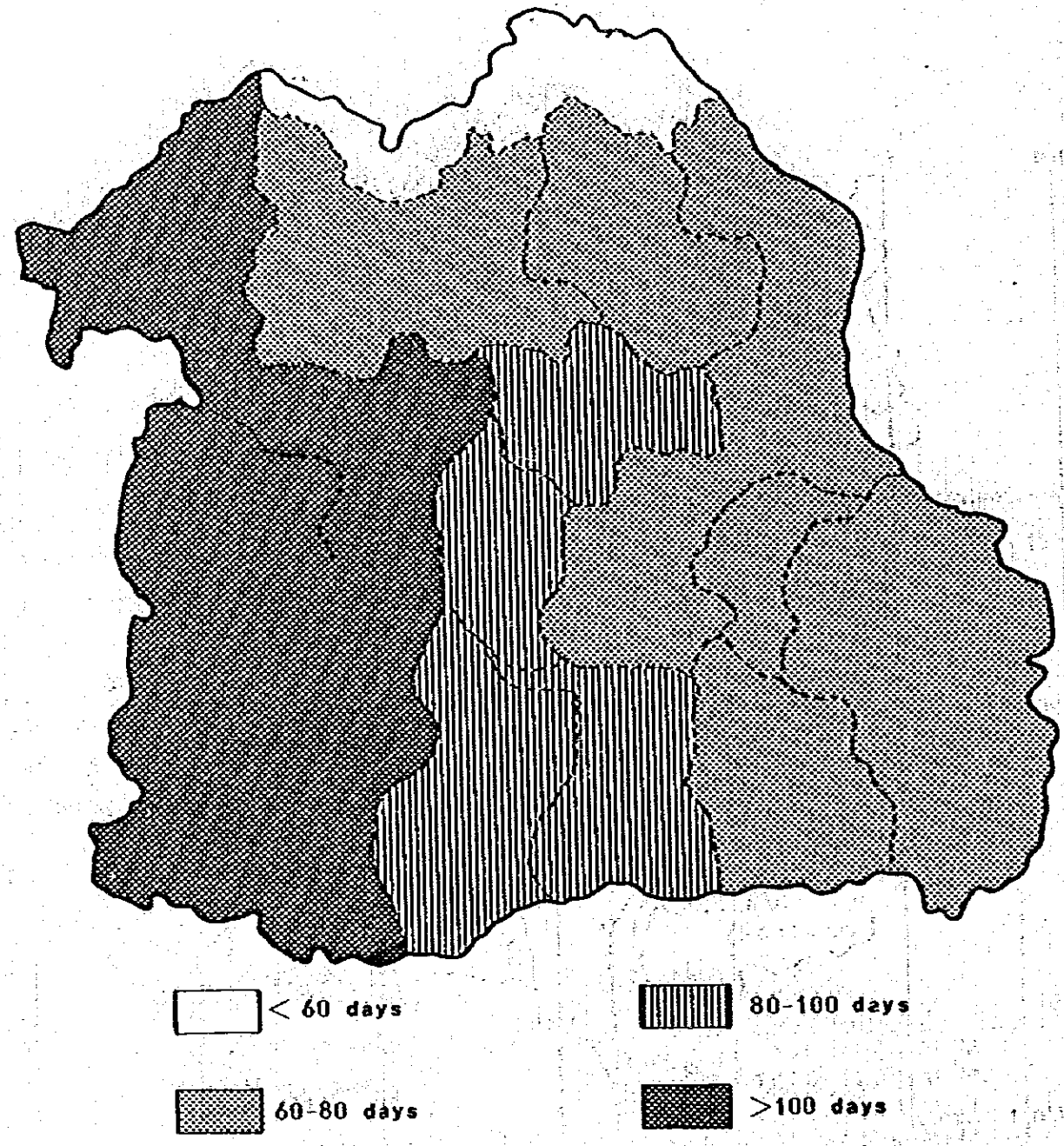


Fig.10 Number of total drought days (calculated for paddy) for the period of May to October (Ref. 13 . Original source: ESCAP 1974).

Agriculture in the Northeast

Thailand initiated the first National Economic and Social Development Plan in 1961 and has currently been in the stage of the fifth Plan starting from 1982. During the two decades under the Development Plan, the national economy had steadily developed with around seven percent of annual growth rate of gross domestic product (GDP) in real terms.

Despite rapid structural changes in the Thai economy, agricultural sector (including fisheries) continues to be dominant, employing 71% of the total labour force (22.5 million in 1980) and producing 24% of GDP (Baht 803 billion in 1981) and 49%* of total export (Baht 153 billion in 1981). Under the fourth Plan (1976-1981), however, the annual growth rate of the agricultural sector reached three percent in contrast to around four percent recorded during the previous Plans (1961-1976). At present, approximately one third of the population in the rural areas is estimated to be still below the poverty line.

In this connection, the fifth Plan (1982-1986) has focussed, among others, on eradication of poverty in the depressed areas as well as development of social structure and decentralization of social services. For development of the rural areas which so far have less benefited from development assistance, the Plan is intended to adopt a series of innovative strategies such as; development planning adapted to each locality based on its specific conditions and basic needs; inviting people's participation in planning and implementation of development projects; development and diffusion of appropriate technology suited to farmers. Under the Plan, the Northeast and North are the major target areas for development.

The Northeast constituting one third of both the land area and population of the whole Kingdom, accounted for only 15% of GDP in 1979; GDP per

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* The ratio exceeds 60%, in case processed agricultural products such as sugar, molasses and tinned foods are included.

capita in the region amounted to Baht 4,991 or 41% of the national average (Baht 12,067) in the same year. More than a half of the below-poverty-line population in rural areas lives in the Northeast.

It is generally recognized that land originally suitable for farming amounts to ten million ha. out of the total area of 17 million ha. in the Northeast; and that cultivable land would amount to a little more than six million ha., with the exclusion of deeply flooded areas, stream beds, towns and villages, and topographically unsuitable land. The cultivable land consists of soil groups well to moderately suited for paddy and those similar for upland crops, based on F. R. Moormann (1972)'s classification and soil map[23].

At present, 50,093 thousand rai (8,015 thousand ha.) or 47.1% of the total land area of the Northeast has been utilized as farm land as shown in the following table. The table shows that land of the Northeast has been reclaimed at the highest rate as compared with that of other regions.

Land Utilization

Unit: 1,000 rai

Regions	Total land (1)	Farm land					Unclassified	(2)/(1)	(3)/(2)
		Total (2)	Paddy (3)	Upland crops	Tree crops	Others			
Whole Kingdom	321,250	118,999	73,563	25,758	11,142	8,535	202,251	37.1%	61.8%
Northeast	106,391	50,093	35,886	9,901	461	3,844	56,298	47.1	71.6
North	106,254	26,025	16,783	7,182	758	1,302	80,229	24.5	64.5
Central	64,737	29,063	16,055	8,572	2,280	2,157	35,674	44.9	55.2
South	43,868	13,818	4,839	103	7,643	1,232	30,050	31.5	35.0

Source: Agricultural Statistics, Crops Year 1980/81

It is difficult to estimate land areas covered with forests in the previous decades. According to the forest inventory based on aerial photographs of 1961, the forest area of the Northeast was 78,153 sq. km. or 45.9% of the total land area. The forest consisted of evergreen forests, mixed deciduous, dry Dipterocarps, pine forests etc.[22] Fig. 11 shows degradation of forests in the region between 1954-1973. The land use map derived from LANDSAT I imagery of 1973 was compared with aerial photographs taken in 1954. The degradation of forests during the period was estimated to amount to about 60% of the 1954 forest cover.[24] Interpretation of LANDSAT imagery in 1978 revealed that forests covered 31,22 sq. km. or 19% of the total land area in the Northeast (forests coverage nationwide was 34%)[18].

It is thus quite obvious that the Northeast has been reclaimed for human livelihood beyond the land capacity and crops are partly grown on land originally unsuited to them. Table 5 shows the population increase in the Northeast from 1947 to 1970. From 1947 to 1960 the population in the Northeast increased at the same rate as that of the whole Kingdom; for another ten years (1960-1970) the population of the former increased at a little higher rate than the latter. The population growth rate varies greatly from province to province. Provinces with quick growing rates are those with a basically low population density. There seems to be a trend of migration towards a more evenly distributed population in the region.

The average farm size in the Northeast was 28.04 rai (4.49 ha.) which was a little larger than the national average, 26.64 rai (4.26 ha.), in 1980/81. More than 90% of the farmholdings are operated by owner-cultivators.

Table 6 shows the statistics of the major crops in 1980/81. Rice (main season), maize, cassava and kenaf are the major crops in the Northeast; these crops constitute 50, 25, 61 and 99%, respectively, of the total

acreage planted to the same crops in the whole Kingdom. In contrast to other regions, a considerable acreage of paddy fields in the Northeast, is planted to glutinous rice. According to the Agricultural Census in 1963, glutinous rice accounted for 68.7% of the planted area and 70.1% of rice production in the Northeast[19]. The Northeast as a whole is nearly self-sufficient in rice as shown in Fig. 12 although Nong Khai, Loei, Khon Kaen and Nakhon Ratchasima are importing rice from other provinces. It was reported that rice production in the Northeast had been as stable as in other regions until the mid-1940's. At that time, the acreage planted to rice was less than ten million rai in the region[19].

Among upland crops, maize, cassava and kenaf account for 78% of the upland fields of the region. The acreage planted to maize and kenaf has rapidly increased since the late 1950's; that planted to cassava since the late 1960's, in parallel with economic development of the region which was mostly induced by highway construction. Nakhon Ratchasima and Loei are the major provinces producing maize. Cassava and kenaf are extensively grown in the Northeast, but Nakhon Ratchasima, Nong Khai, Udon Thani, Kalashin, Khon Kaen and Buri Ram are ranked higher in cassava production.

Besides those crops, sugar cane is grown over a limited acreage in the region with Udon Thani, Khon Kaen, Kalashin and Buri Ram being the major provinces.

The Government of Thailand has been promoting the construction of irrigation facilities to alleviate production constraints in the Northeast. The following is the summary of the existing and planned irrigation projects in the region:

Irrigable area (rai) in the Northeast[16]	
From existing large reservoirs	1,193,300
From existing tanks	1,112,195
From pumping	1,900,000
Total Irrigable Area from Existing Resources	4,205,495 rai

From planned large reservoirs (excluding Pa Mong)	2,218,650	
From planned tanks	754,545	
Total Irrigable Area from Planned Resources	2,973,195	rai
Total Potential Irrigable Area	7,178,690	rai

The Location of those irrigation projects is shown in Fig. 13.

The total potential irrigable area amounts to 7,718,690 rai corresponding to only 20% of the paddy fields in the Northeast. Undoubtedly, many other irrigation projects are under planning, but irrigation potential in the Northeast is unlikely to be large due to the flat topography of the region. Thus, it is highly probable that most of the upland crops will have to be grown under rainfed conditions.

As mentioned before, the land of the Northeast has been extensively reclaimed beyond its original capacity. Evaluation of natural environment and resources for planning proper land use is urgently needed to protect the land capabilities against further degradation. At the same time, utmost efforts should be made to develop the agricultural technology suited to each locality to stabilize crop production through the identification and elimination of specific production constraints.

Table 5. Population Development in the North-east

Province	Population (in thousand)				Area in sq.km.	Population density per sq.km.		
	1947	1960	1970	Increase 3)		1947	1960	1970
Buri Ram	335	584	797	3.17	10,771	35	54	74
Chaiyaphum	292	486	626	2.55	10,788	30	45	58
Kalasin	1)	427	573	2.99	7,650	1)	56	75
Khon Kaen	591	844	1,025	1.96	13,404	43	63	77
Loei	136	211	326	4.45	10,936	12	19	30
Maha Sarakhan	707	499	613	2.08	5,760	46	87	106
Nakhon Phanom	314	436	561	2.53	9,749	32	45	58
Nakhon Ratchasima	738	1,095	1,547	3.52	19,590	36	56	79
Nong Khai	144	257	442	5.58	7,223	19	36	61
Roi Et	536	668	780	1.56	7,856	85	85	99
Sakon Nakhon	270	427	598	3.43	9,539	26	45	63
Si Sa Ket	472	601	790	2.77	8,813	53	68	90
Surin	438	582	747	2.53	8,784	48	66	85
Ubon Ratchathani 2)	856	1,131	1,480	2.73	22,758	37	50	65
Udon Thani	386	744	1,118	4.16	16,605	32	45	67
North-east	6,216	8,992	12,023	2.95	170,226	33	53	71
North	2,024	5,723	7,468	2.70	170,006	12	34	44
Central	7,048	8,271	10,392	2.31	103,579	68	80	100
South	2,161	3,272	4,269	2.70	70,189	31	47	61
Whole Kingdom	17,443	26,258	34,152	2.66	514,000	34	51	66

Note: 1) Included in Maha Sarakam.
2) Includes Yasothon.
3) Average annual rate of population growth from 1960 to 1970 in percent.

Source: Ref. and
National Statistical Office. 1974: Statistical Year Book. Thailand. No. 29. 1970 - 1971.

Table 6. Statistics of Major Crops (crop year 1980/1981)

Crop \ Region	Planted area (1,000 rai)					Production (1,000 tons)					Yield per rai (kg/rai)				
	W.K.	NE	N	C	S	W.K.	NE	N	C	S	W.K.	NE	N	C	S
Major rice crops	56,882	28,224	12,550	12,032	4,076	15,405	5,749	4,663	3,872	1,122	271	204	372	322	275
Second rice	3,227	148	352	2,652	75	1,963	62	197	1,672	32	608	420	558	630	429
Maize	8,960	2,267	4,658	2,016	19	2,998	730	1,648	615	5	335	322	354	305	263
Cassava	7,250	4,432	215	2,500	-	16,540	10,009	488	6,043	-	2,281	2,258	2,270	2,417	-
Sugar cane	2,927	294	366	2,266	-	19,854	2,187	2,572	15,095	-	6,783	7,439	7,027	6,662	-
Mungbeans	2,796	88	2,217	463	28	261	10	218	31	2	93	114	98	67	71
Sorghum	1,546	30	719	797	-	237	5	89	143	-	153	167	124	179	-
Soybeans	788	36	683	69	-	100	5	86	9	-	127	139	126	130	-
Ground nuts	658	151	369	104	34	129	25	76	21	7	196	166	206	202	206
Cotton	949	165	441	343	-	193	40	78	75	-	203	242	177	219	-
Kenaf	1,068	1,055	-	13	-	211	208	-	3	-	198	197	-	230	-

Region : W.K. --- Whole Kingdom ; NE --- North-Eastern ; N --- Northern ; C --- Central Plain; S --- Southern

Source : Agricultural Statistics of Thailand, Crop Year 1980/81

Table 7. Accumulated Irrigated Area
(Completed up to 1980)

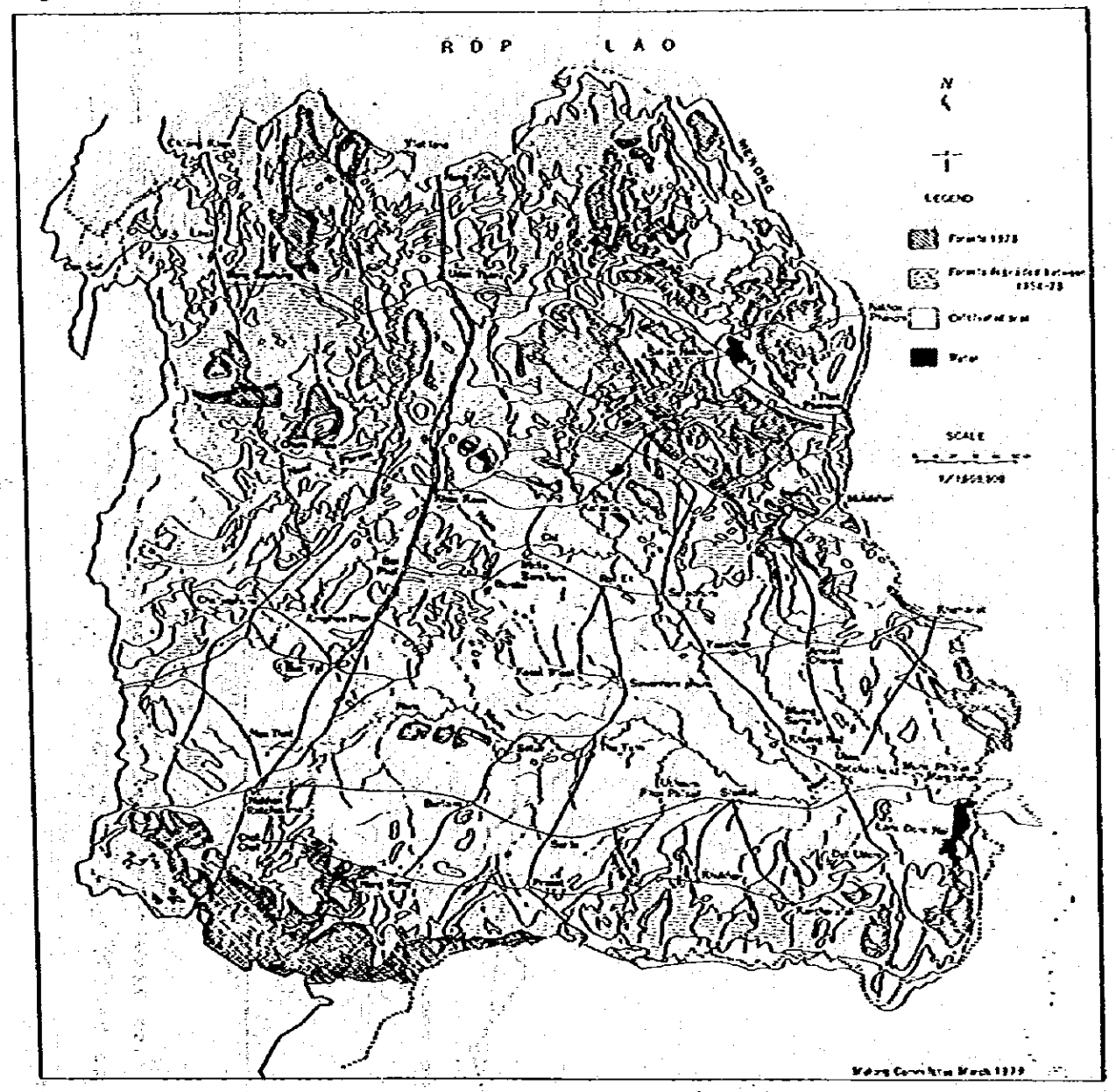
Unit: Rai

Type of work	Northern	North-Eastern	Central	Southern	Whole Kingdom
I	2,593,910	467,580	1,900,200	654,870	5,616,560
SI	76,350	869,545	62,700	4,500	1,013,095
C	340,800	24,150	69,600	54,200	488,750
P	63,850	15,000	9,475	67,000	155,325
D	61,000	450	12,000	9,500	82,950
F	12,500	-	20,000	77,000	109,500
S	-	1,100	2,500	-	3,600
CD	1,000	-	140,500	288,900	430,400
DC	-	-	40,500	-	40,500
CF	-	-	407,500	377,500	785,000
FC	288,000	293,000	145,500	3,000	729,500
IC	95,100	-	-	-	95,100
ID	152,900	180,000	5,189,900	-	5,522,800
PD	30,900	94,000	183,700	-	308,600
ICD	-	-	1,610,000	-	1,610,000
IPD	60,000	-	132,000	-	192,000
ICR	-	-	510,000	-	510,000
IPC	-	-	146,000	-	14,600
CDF	-	-	2,000	66,000	68,000
SIF	-	25,000	8,500	-	33,500
ICRD	-	-	525,000	-	525,000
SIFD	-	316,000	-	-	316,000
SIFH	33,000	-	-	-	33,000
SIFR	-	-	142,000	-	142,000
-	14,800	3,300	210	1,500	19,810
Total	3,824,110	2,289,125	11,128,385	1,603,970	18,845,590
Paddy Area Irrigated (%)	16,782,961 22.8	35,886,374 6.4	16,054,745 69.3	4,838,906 33.2	73,562,985 25.6

Note: I -- Irrigation, S -- Storage of water, P -- Pumping,
R -- Reclamation, C -- Conservation, D -- Drainage,
H -- Hydroelectric Power, F -- Flood protection,
- -- For domestic use

Source: Agricultural Statistics, 1980/1981

Fig. 11 DEGRADATION OF FORESTS BETWEEN 1954 - 1973 in the Northeast (Ref. 24)



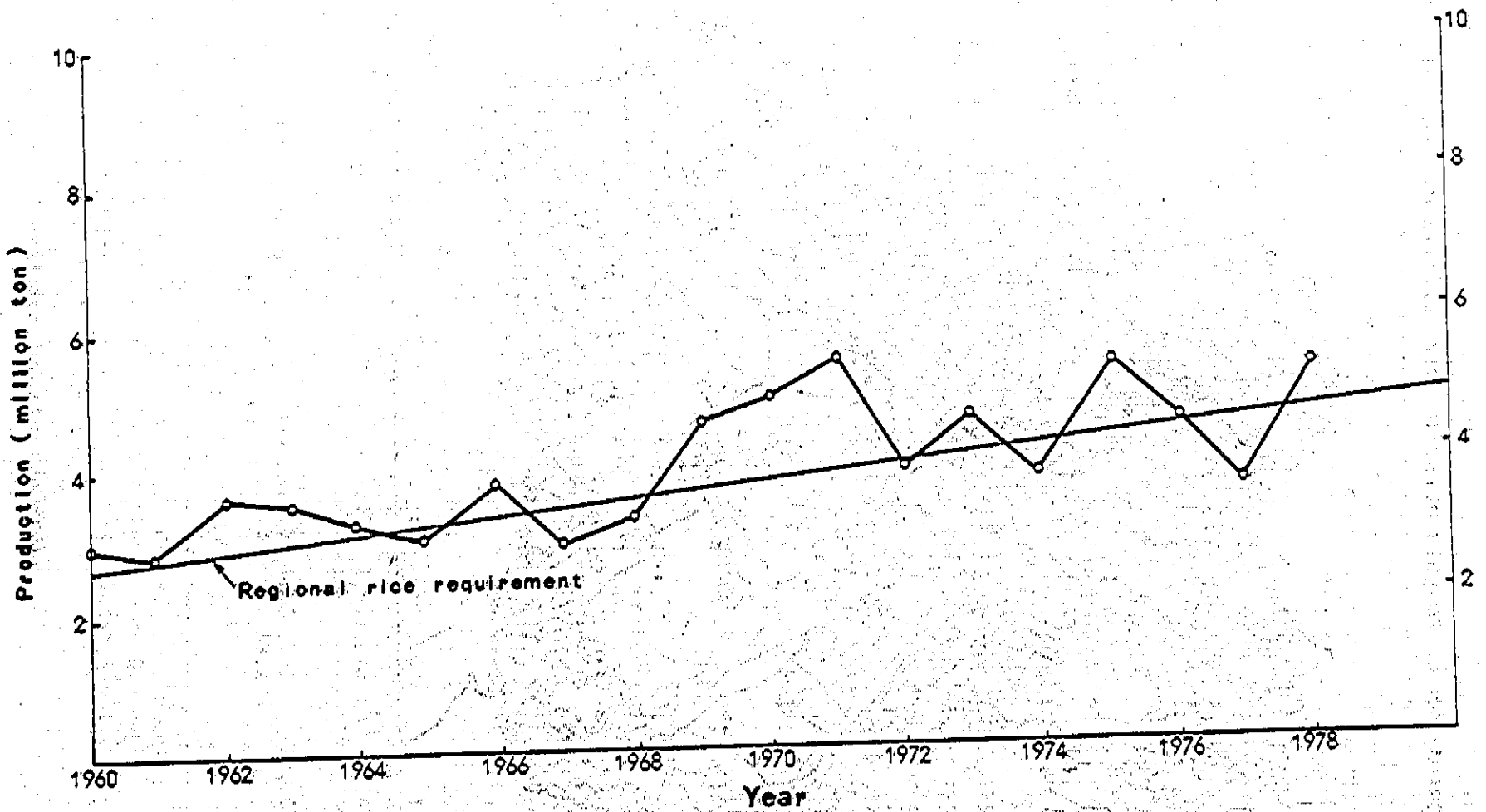


Fig. 12 Regional rice requirement and annual production (per capita annual rice requirement assumed to be 300 kg). (Ref. 13)

図12 地域別米の需要と年生産量

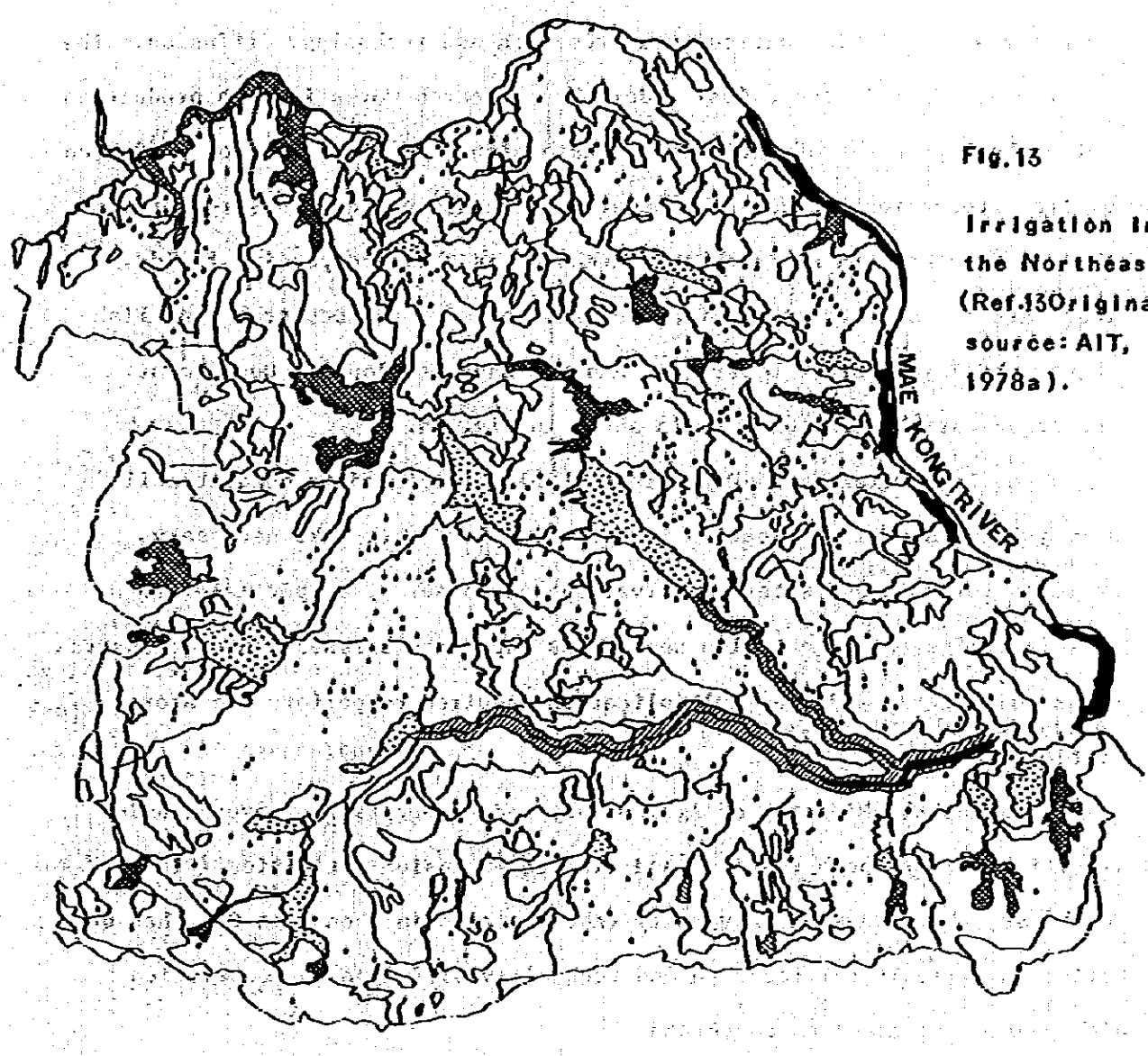


Fig.13

Irrigation in the Northeast (Ref.13Original source: AIT, 1978a).

• Small tanks (completed and planned)

Dry season
Wet season
} Pump irrigation (existing and potential)

Reservoir
Irrigated area
} Irrigation from large reservoir (existing and potential)

Research Institutions Participating in the Project

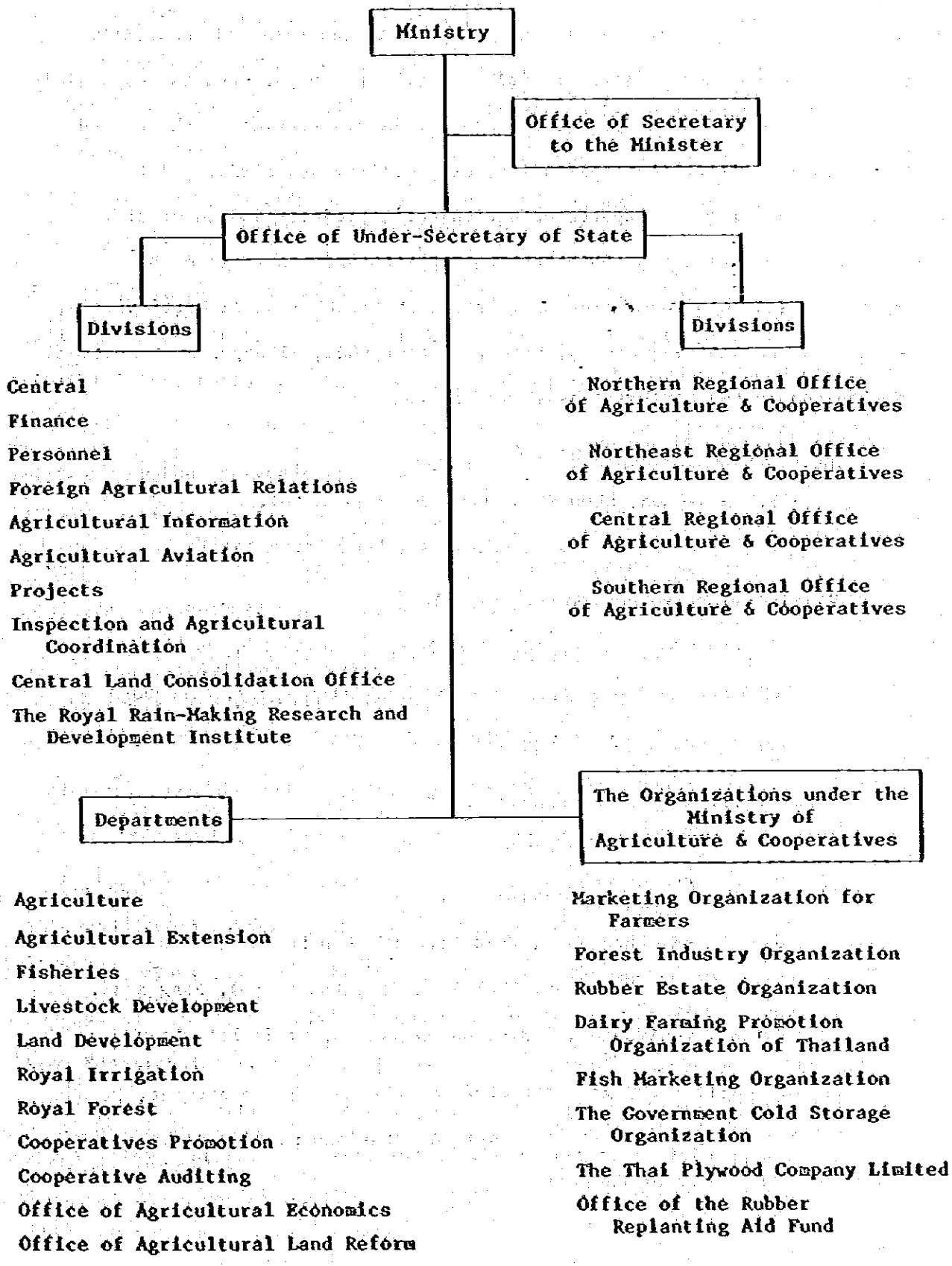
The Ministry of Agriculture and Cooperatives (MOAC) is the principal agency responsible for agricultural research and technology diffusion. The Department of Agriculture (DA) undertakes research works in crop production while the Department of Agricultural Extension is responsible for diffusion of crop production technology. Other Departments of the Ministry perform their duties both in research and extension in their respective fields. These are the Department of Livestock Development, the Department of Fisheries, the Royal Forest Department and the Land Development Department. The organization chart of MOAC is shown in Fig. 14.

The Land Development Department (LDD) is assigned to conduct soil surveys and land classification for planning land use, take necessary measures for soil and water conservation and to set up proper land use policies. The Department also undertakes experiments/researches, demonstrations to farmers, and seed multiplication required to perform the aforementioned duties.

Besides the Ministry of Agriculture and Cooperatives, several universities perform both research and limited extension activities. In the Northeast, the Khon Kaen University (KKU) located in Khon Kaen City has been active in agricultural research and technology diffusion in cooperation with government agencies concerned.

The present project is planned for three institutions, DA, LDD and KKU to implement. These institutions are different in their history, functions, characteristics and so forth. For this reason, the project will be implemented by these institutions more or less independently so that each institution may concentrate on its own duty. The coordination of research activities will be made at the business level by a research committee with representation by three institutions, and in administrative aspects at a high level by the coordinating Committee already established in Bangkok, as described later.

Figure 14. Organization Chart of the Ministry of Agriculture and Cooperatives (MOAC)



1. The Department of Agriculture

The Department of Agriculture (DA) is the main Department responsible for agricultural research in the Ministry of Agriculture and Cooperatives (MOAC). In addition to agricultural research, the Department is responsible for several agricultural production and regulatory services such as seed (breeder, foundation) multiplication, crop quality standards, and the control of imports and exports of agricultural products and chemicals. The Department has its Headquarters in Bangkaen and a network of 85 experiment stations consisting of 22 rice, 19 field crop, 11 horticulture, 14 sericulture and 19 rubber stations. Out of them, 31 experiment stations are located in the Northeast as shown below:

Rice Experiment Stations : 6

Sakon Nakhon, Khon Kaen, Chumpae (Khon Kaen), Surin, Pimai (Nakhon Ratchasima), Ubon Ratchathani

Field Crop Experiment Stations : 10

Kalasin, Khon Kaen, Maha Sarakham, Sakon Nakhon, Non Sung (Nakhon Ratchasima), Banmai (Nakhon Ratchasima), Mukdaharn (Nakhon Phanom), Roi Et, Loei, Ubon Ratchathani

Horticulture Experiment Stations : 2

Nakhon Phanom, Si Sa Ket

Sericulture Experiment Stations : 13

Udon Thani, Khon Kaen, Mukdaharn (Nakhon Phanom), Ubon Ratchathani, Buri Ram, Phut Thai Song (Buri Ram), Nong Khai, Roi Et, Chaiyaphum, Surin, Sakon Nakhon, Si Sa Ket, Loey

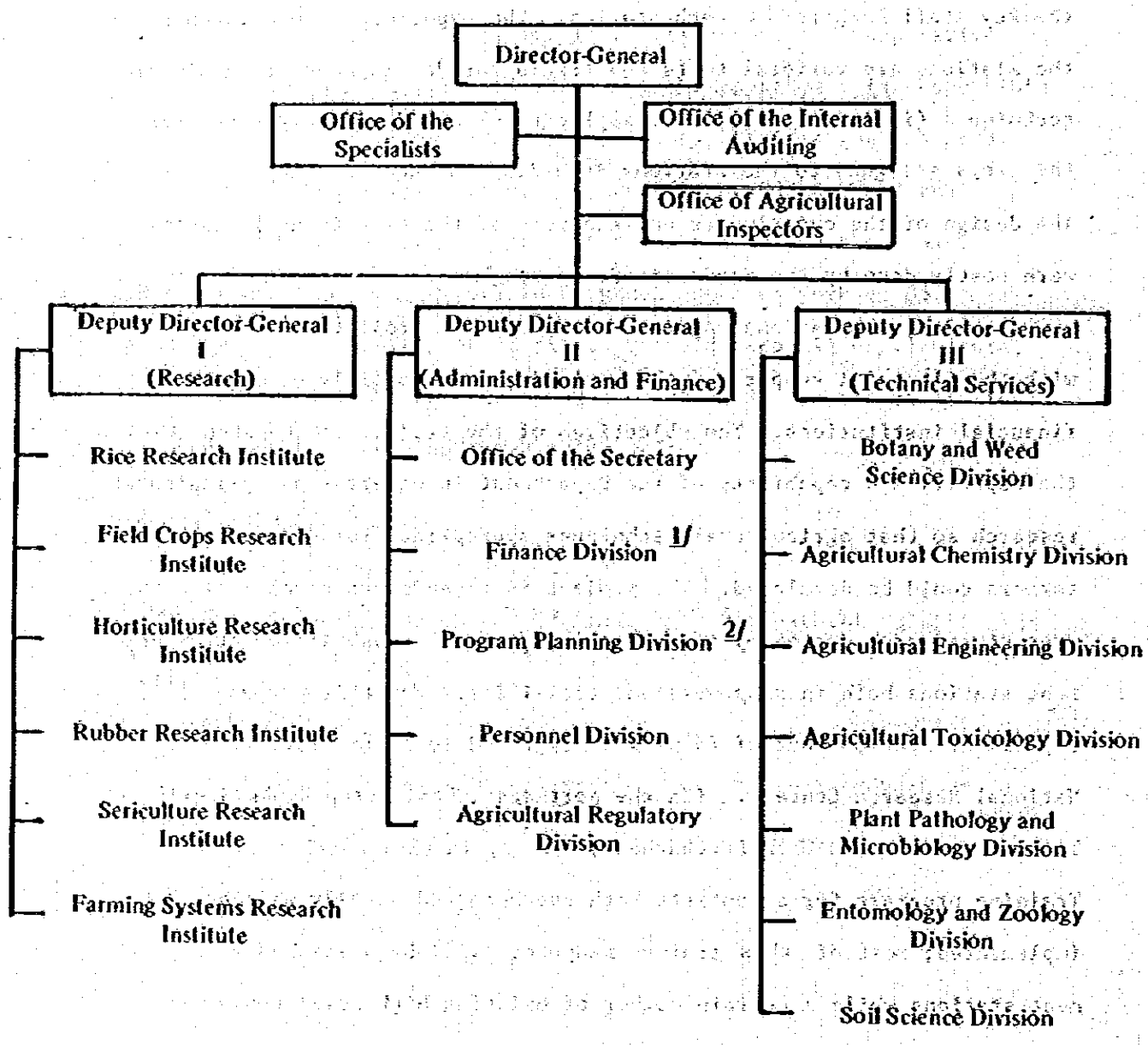
Out of nearly 1,200 graduate staff members of the Department, around 25% are assigned to the 85 experiment stations mentioned above; the rest are stationed at Bangkaen.

In most cases, the experiment stations are staffed with a few university graduates and several diploma (vocational) level staff members as the key staff members in each station. The experiments undertaken at the stations are varietal tests and trials for development of cultivation techniques (including fertilizer application) and farming systems, for the crops assigned to the stations according to each locality. The design of the experiments and analysis of the experimental results were mostly done by the Headquarters in Bangkaen.

In 1981, the National Agricultural Research Project was started with the financial support of the World Bank and possibly some other financial institutions. The objectives of the Project are to strengthen the capacity and capability of the Department in undertaking agricultural research so that agricultural techniques appropriate for dissemination to farmers could be developed. The project is intended to decentralize the present research system by strengthening research capabilities of experiment stations both in manpowers and facilities. For this purpose, 19 experiment stations out of 85 will be upgraded to multi-disciplinary National Research Centers. (In the Northeast, field crop centers will be in Khon Kaén and Ubon Ratchathani; rice, in Ubol Ratchathani). Training programs for scientists both overseas and locally will be implemented; most of this trained manpower will be stationed at experiment stations while a certain number of existing high level posts will be moved from Bangkhen to the experiment stations.

The organization of the Department has been changed in 1982 as shown in Fig. 15. Among the Divisions/Institutes of the Department, the Field Crop Research Institute is responsible for varietal improvement and development of cultivation techniques including fertilizer application and farming systems. The staffing of the Institute in 1983 is planned

Fig. 15. ORGANIZATION CHART
OF DEPARTMENT OF AGRICULTURE



1/ Includes a Procurement Unit
2/ Includes Monitoring and Evaluation Unit

Table 8. Staffing of Field Crop Research Institute

	Researcher (D.Sc. and up)	Technician & support staff	Total
Director	1	-	1
Senior Agricultural Staff	7	-	7
Seed Technological Laboratory Staff	6	1	7
Fibre Quality Laboratory Staff	1	4	5
Administration Section	12	13	25
Inspection Evaluation Section	5	-	6
Training Section	5	1	6
Total	37	19	56
%	20	10	15
Khon Kaen Field Crop Research Center	14	11	25
-Kalasin Field Crop Experiment Station	7	9	16
-Maha Sarakham " "	5	13	18
-Roi Et " "	5	8	13
-Loei " "	4	13	17
Chainat Field Crop Research Center	14	10	24
Chiangmai " "	13	13	26
-Sukhothai Field Crop Exp. Sta.	7	9	16
Nakhonsawan Field Crop Research Center	14	10	24
-Nakhon Ratchasima Field Crop Exp. Sta.	4	7	11
-Phitsannlok	5	2	7
-Loburi	9	10	19
Rayong Field Crop Research Center	10	8	18
Suphanburi " "	10	12	22
-Patthalung Field Crop Exp. Sta.	3	8	11
Ubon Ratchathani Field Crop Research Center	8	6	14
-Nonsoong Field Crop Exp. Sta.	5	9	14
-Mukdahan " "	4	9	13
-Sakon Nakhon " "	4	5	9
Total	145	172	317
%	80	90	85
Grand Total	182	191	373

Note: The underlined are in the Northeast

as shown in Table 8.

The Khon Kaen Field Crop Experiment Station which will be upgraded to the Field Crop Research Center is located near Khon Kaen city, at the next door of KKU. It has approximately 300 rai (48 ha) of experimental field. Presently, it is staffed with nine agronomists, 11 technicians and more than 40 support staff. The annual budget was Baht 2,314,790, out of which 63% is allocated for salaries of staff members and wages for employees. Crops taken up for varietal trial are kenaf, soybean, peanut, mungbean, cassava, maize and sorghum. Experiments on cultivation techniques for these crops including intercropping with some other crops are also under way. The Station also undertakes seed multiplication in a part of the field of around 140 rai (22.4 ha).

The Soil Science Division is undertaking a series of research works on soils with reference to soil-plant relationship which include improvement of soil fertility through proper management of soils and crops both in upland and paddy fields. The number of the staff members is 318 consisting of 15 Ph.Ds., 67 M.Scs., 108 B.Scs. and 128 Diploma level (mostly with certificates of vocational education).

The Field Crop Soil and Fertilizer Branch of the Division is staffed with 100 members consisting of 52 researchers (3 Ph.Ds., 21 M.Scs. and 28 B.Scs.) and 48 research assistants (diploma level). Out of 100 staff members 68 are stationed in upcountry; that is, 10 in the North, 39 in the Central and 19 in the Northeast. In the Northeast, they are grouped in four so that each group covers a Zone composed of three or five provinces. They conduct fertilizer trials at farmers fields in cooperation with neighbouring experiment stations when and if necessary. They also assist extension workers.

The scope of the research of the Branch include maintenance and improvement of soil physical and chemical properties (including fertility); examination of crop suitability; and fertilizer trials to set up recommendation for fertilizer application. The number of fertilizer trials undertaken in the Northeast in 1982 is shown below.

Crops	No. of trials
Kenaf	6
Cassava	5
Corn	4
Sorghum	2
Cotton	4
Soybean	2
Peanut	3
Mungbean	2
Castor bean	2
Sesame	2
Sugarcane	2
Secondary and trace element	1
Organic amendment and soil management	7

The Soil Science Division has some other branches such as the Soil Chemistry and Fertility Branch (10 M.Scs., 2 B.Scs. and 3 research assistants), the Soil Microbiology Branch (2 Ph.Ds., 4 M.Scs., 6 B.Scs. and 4 research assistants) and the Rice Fertilization Branch (3 Ph.Ds., 9 M.Scs., 8 B.Scs. and 3 research assistants who are stationed at Bangkaen, plus 4 B.Scs. and 9 research assistants stationed in upcountry).

2. Land Development Department

The Land Development Department (LDD) was established in 1964 with the assignment of conducting soil surveys, soil classification, soil improvement, soil and water conservation, land planning and land policies. At present, LDD is responsible for the following activities:

1) Soil survey and soil analysis for the maximum usage of land, as well as soil improvement and preparing the country soil maps.

2) Soil survey and land capability classification.

3) Analysis of soil fertility by geographic condition, soil productivity and tenancy.

4) Study, research, demonstration, and operation of land development program.

5) Prevention of soil deterioration by soil and water conservation.

6) Improvement of infertile soil and unused land for reviving utility.

7) Land use and tenancy survey.

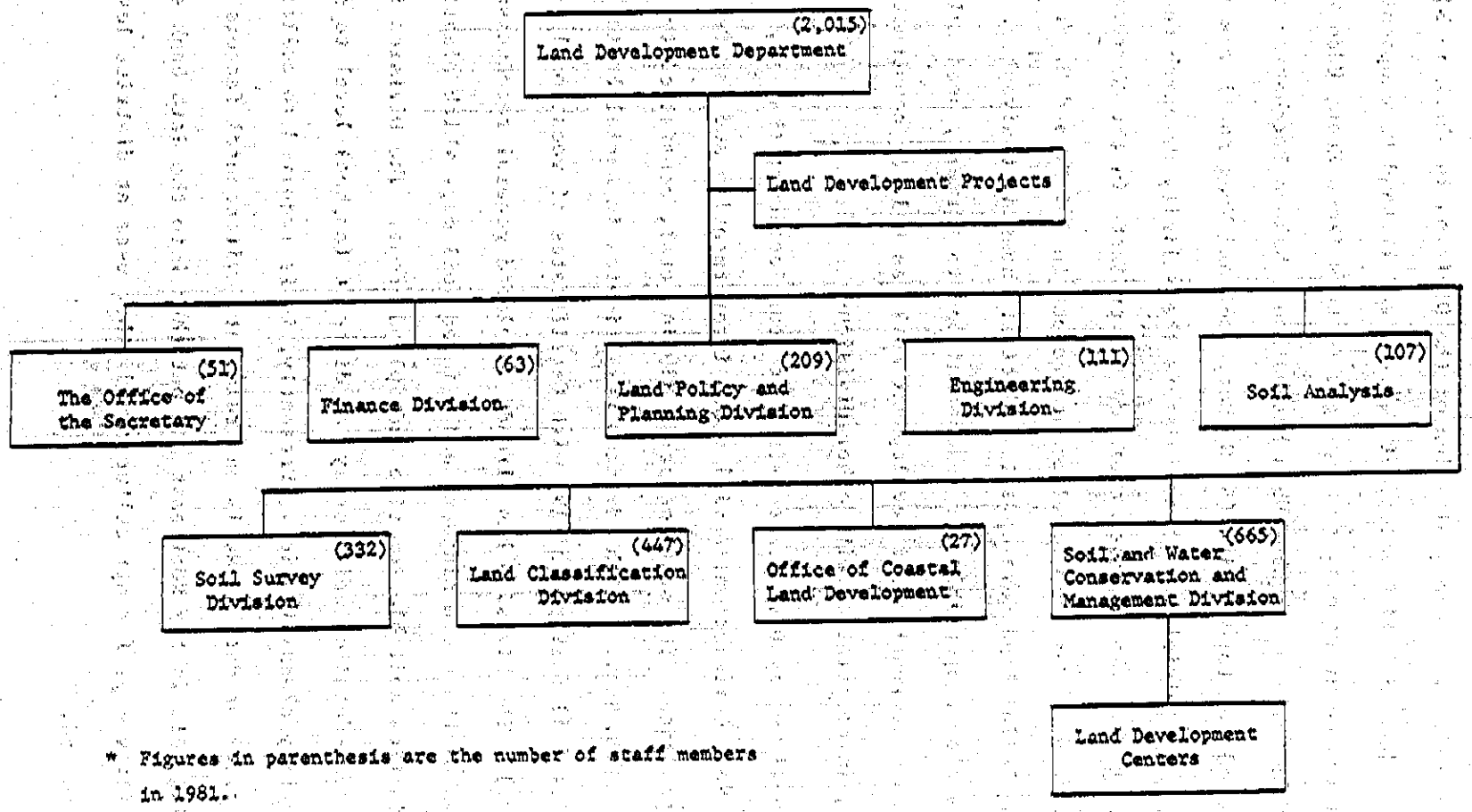
8) Conducting experimental plots on land development in order to study the capability of soil for maximal land utility.

9) Analysis and evaluation land development programs for planning and setting proper land use policy of the country.

10) Advising and distributing information and knowledge of land development to farmers and population.

The organization chart of LDD is shown in Fig. 16. Among the Divisions of the Department, the Soil and Water Conservation and Management Division is the biggest one with 643 staff members consisting of four Ph. Ds., 44 M. Scs., 137 B. Scs., 123 with Certificates of five years' vocational education

Fig. 16 - The Organization Chart of Land Development Department

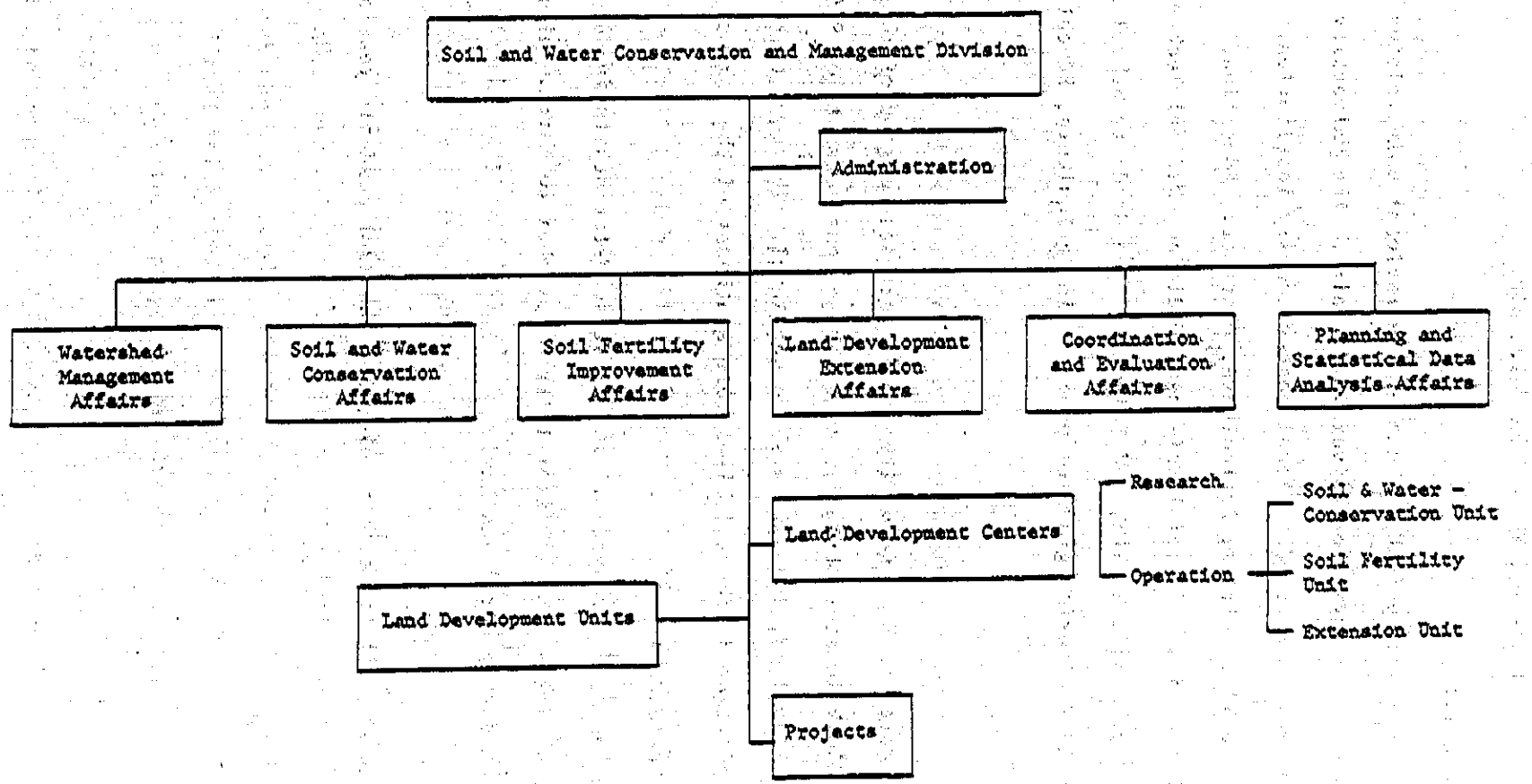


* Figures in parenthesis are the number of staff members in 1981.

(agriculture), 258 with three years' of the same education and 77 in typing & general services. The organization of the Division is shown in Fig. 17. The Division has 23 Land Development Centers and 12 Land Development Units throughout the country; out of them, eight Centers (Khon Kaen, Udon Thani, Kalasin, Maha Sarakam, Borabu, Ubon Ratchathani, Nakhon Ratchasima and Nakhon Phanom) and three Units (Si Sa Ket, Loei and Nong Khai) are in the Northeast. The Division also administers the Salinity Research Center at Cho Ho, Korat. The Division operates two projects in the Northeast: the Tung Kula Rong Hai Land Development Project in Roi Et and H. M. the King's Tung Luilai Land Development Project at Khonsan, Chaiyaphum. The Division is also responsible for demonstrations to farmers, seed multiplication, land conservation and development work as well as constructing farm ponds, in cooperation with other Divisions.

The Soil Survey Division consists of four Sections; that is, Field Operation, Soil Correlation, Aerial Photo Interpretation and Map Reproduction, and Correspondence. The staff members, 330 in total, consist of two Ph. Ds., 28 M. Scs., 98 B. Scs., 7 with Advanced Certificates in Aerial Photo Interpretation for Soil Survey, and 195 with Certificates of vocational education (agriculture). The Division has already completed general reconnaisance soil surveys of the whole Kingdom, and printed soil maps which classified soil capabilities suitable for rice and upland crops. The Division is now conducting semi-detailed soil surveys at district (amphoe) level to determine soil suitability classification. Presently, it is required to collect and analyze a series of data on soils and relevant environmental factors of every mapping unit in the Northeast and put them into the data bank so that land suitability maps for agricultural and other uses at district level could be produced.

Fig. 17. Organization Chart of Soil and Water Conservation and Management Division



3. Faculty of Agriculture, Khon Kaen University

3.1 Name and origin:

Khon Kaen University (KKU) is one of the regional universities under the supervision of the Office of University Affairs. The University was established in 1964 as a co-educational post-secondary institution. At present there are 11 faculties; Agriculture, Dentistry, Education, Engineering, Humanities and Social Sciences, Medicine, Medical Technology, Nursing, Pharmacy, Public Health, and Sciences. The Graduate School was established in 1979 offering graduate programs in Agriculture, Education and Engineering.

3.2 Location:

KKU is located in Khon Kaen City in the Northeast region of Thailand, approximately 450 kilometers from Bangkok. The campus consists of 900 hectares of rolling land, 200 meters above sea-level. The town of Khon Kaen with 93,000 population is about 4 kilometers southeast of the campus.

3.3 Academic calendar:

KKU uses the semester system. The first semester starts in June and ends in October. The second semester is from November to March. There is a summer session during April and May.

3.4 Enrollment:

Enrollment figures for each faculty for the 1981 academic year are as follows:

Faculty	Enrollment
Agriculture	686
Dentistry	58
Education	824
Engineering	858
Humanities and Social Sciences	170
Medicine	400
Medical Technology	72
Nursing	545
Public Health	56
Sciences	461
Graduate School	95
Total	4,225

Approximately 41% of total enrollment is female. A majority of students (60%) is from the Northeast. In the Faculty of Agriculture 24% comes from farm families and 17% is female. New enrollment for the Faculty of Agriculture has remained at 180 students annually for the past few years because of the Faculty's policy to concentrate on quality. During the Fifth National Economic and Social Development Plan (1982-1986) the Faculty plans to increase its enrollment at undergraduate level only 10% for that period. Graduate enrollment at master's level, however, will be increased from 14 in 1981 to 83 in 1986, approaching 10% of total enrollment in the Faculty.

At the end of the 1980 academic year 1,275 have graduated from the Faculty. About one-third still work in the Northeast region. The number of graduates who work for the government, however, dropped drastically from 90% of graduating class in the beginning to about 30%, while the percentage of graduates employed by private sector rose from 15 to 40%.

3.5 Facilities:

As a residential university KKU at present maintains 20 dormitories

capable of housing 3,500 students or 83% of total enrollment. Housing is also available for most of the University staff on campus.

All faculties, except Education, are located on the upper part of the campus. Central facilities include a student union, a cafeteria, a dining hall, an administration building, a faculty club, a guest house, and main library with approximately 90,000 volumes, 300 Thai language journals and 557 English language journals. Athletic facilities consist of a swimming pool, a shooting range, three soccer fields, indoor badminton courts, several tennis, volleyball and basketball courts.

In addition to the above central facilities, each faculty has its own complex of classrooms and laboratories. The largest complex is the Health Science Center still under construction on the eastern part of the campus.

The Faculty of Agriculture main complex consists of a central administration and classroom building, a laboratory building, a 500-seat auditorium, a service building for experimental food processing, and a Plant and Soil Science building. All of the buildings in the main complex with the exception of the new Plant and Soil Science building were built with grants from the New Zealand Government under Colombo Plan Assistance. Research facilities and equipment are not enough both for educational and research purposes. The Faculty has a small library with about 6,100 volumes of references and textbooks in agriculture and biological sciences. There are 65 titles of Thai journals and 89 titles of English language journals.

The Faculty has a 320 hectares farm on the western part of the campus for training and research. Approximately 130 hectares may be irrigated by a sprinkler system via underground pipelines. The University Farm consists of the following sections: Feed Mill, Poultry, Swine, Beef Cattle,

Dairy Cattle, Fisheries, Veterinary Clinic, Forage Crops, Fruit Crops, Vegetable Crops, Field Crops, Ornamental Plant Nursery, Soil and Fertilizer, Farm Mechanics, Agricultural Meteorology, Sericulture, and Apiculture. The Faculty also has a small experimental station at Chulabhorn Dam (800 meters above sea-level) approximately 140 kilometers from the main campus.

3.6 Faculty:

Most of KKU staff members are young. At present there are 829 full-time faculty members; slightly less than one-half are female. In term of qualifications 14% have doctorate's degrees, 53% master's degrees and 33% bachelor's degrees. In addition there are 5 advisors and 3 volunteers from the Federal Republic of Germany, New Zealand, the United Kingdom and the United States.

In the Faculty of Agriculture the qualifications of the teaching staff of each department are as follows:

Department	Bachelor's	Master's	Doctorate's	Total
Agricultural Economics	-	7	1	8
Agricultural Extension	-	6	1	7
Agricultural Products	4	3	-	7
Animal Science	5	7	13	25
Entomology and Plant Pathology	2	11	4	17
Plant Science	10	15	7	32
Soil Science	1	8	7	16
Total	22	57	33	112

The present Faculty of Agriculture staff received advanced training from 18 countries. In 1981 thirty staff members are on study leave locally and abroad.

The Faculty budget from the government in 1981-82 fiscal year is Baht 24.87 million. The total budget for KKU is Baht 410.80 million.

3.7 Administration:

KKU is a Thai Government university operating under the supervision of the Office of University Affairs (OUA). There is a University Council consisting of the Rector, Vice-Rectors, and deans as ex officio members. The President of the Council and additional 9 - 15 members are appointed by His Majesty the King from recommendations submitted by OUA via the cabinet. The Council's main roles are supervision and policy control. The organization chart of KKU is shown in Fig. 18.

3.8 Foreign assistance:

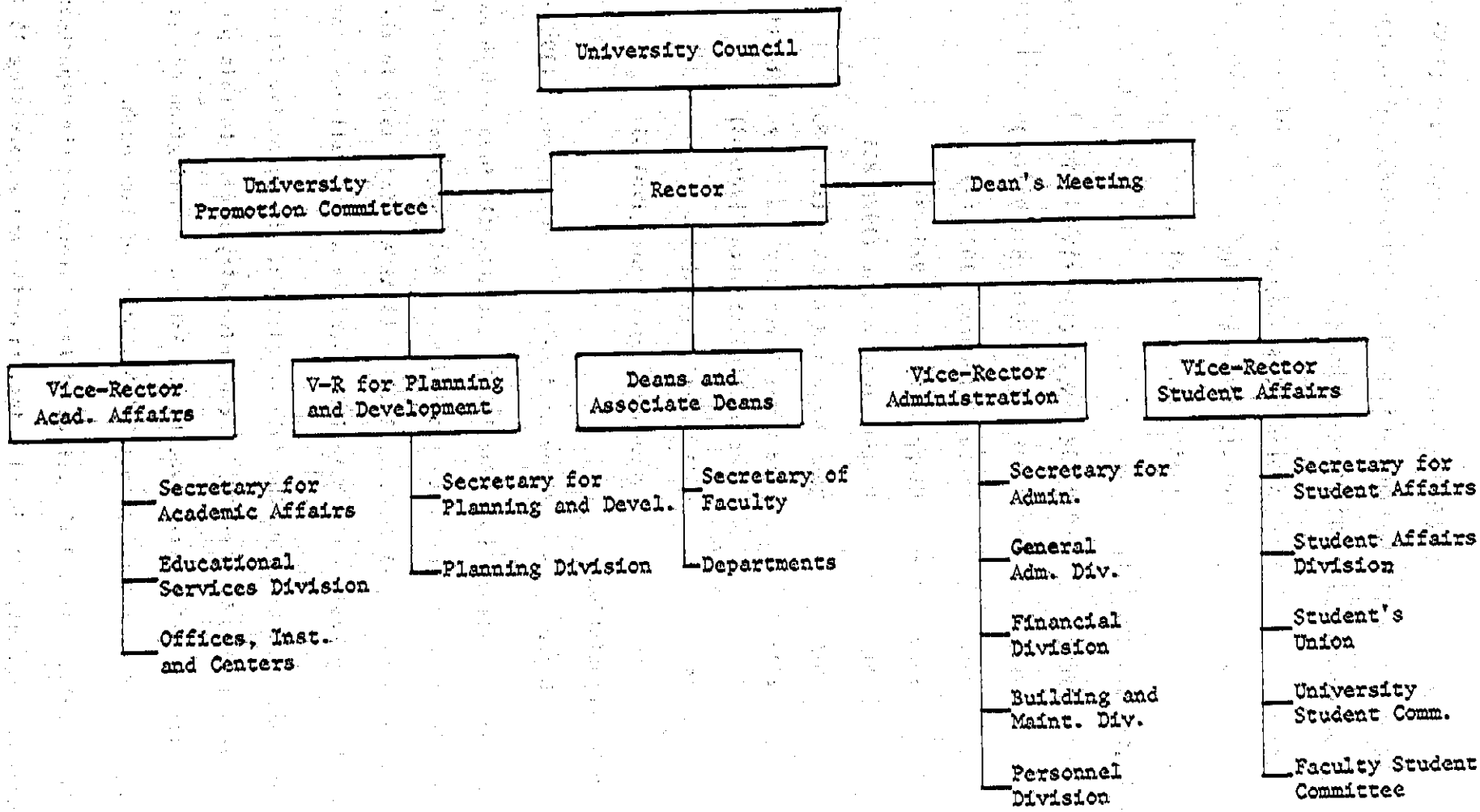
At the beginning KKU has been assisted mainly by Canada and New Zealand under Colombo Plan Assistance. Advisors, scholarships and some grants for buildings and equipments were provided. There were also volunteers from Canada, New Zealand, Federal Republic of Germany, the United Kingdom and the United States.

Currently the Faculty of Agriculture has received foreign assistance mainly from the Australian Development Assistance Bureau (ADAB), the International Development Research Centre (IDRC) and the New Zealand Government. Many foundations such as the Asia Foundation and the Ford Foundation have also given grants for research and training. Starting in 1979 there is a scientist exchange program between KKU and the Japanese Society for the Promotion of Science (JSPS). The Federal Republic of Germany also provides one volunteer to work in Agriculture section.

3.9 Research and extension activities:

In 1979 KKU has been authorized to set up the Office of Research and Development to coordinate and extend research works. The Faculty of Agriculture is also involved in these activities. In 1980-81 fiscal year there are 35 research projects with a total budget of approximately US $ 500,000, roughly

Figure 18. Organization Chart of Khon Kaen University



one-third of the Faculty budget. Most of the research budget (71%) comes from foreign grants (ADAB, IDRC, ICA, USAID, FORD, JSPS). The major on going research projects in 1981-82 fiscal year are:

Budget	:	Approx. US $ 450,000
Funding Sources	:	Foreign Donors 70%
		Thai Government 30%
Major projects	:	
IDRC	-	Cassava Nutrition (1975-82)
JSPS	-	Shifting Cultivation (1979-82)
JSPS	-	Nitrogen Economy (1979-82)
FORD	-	Cropping System (1975-83)
ADAB	-	Pasture Improvement (1976-83)
IDRC	-	Home Processed Legumes (1978-85)
FRANCE	-	Land Cover Inventory and Change Detection using Landsat Data (1981-83)
JSPS	-	Soil Salinity (1982-83)
IDRC	-	Groundnut Improvement (1983-85)
Under negotiation	:	
USAID	-	Integrated Rainfed Farming System (1984-88)

In term of extension the Faculty is not actually involved in extension works but it has cooperated with the Southeast Asia Regional Center for Agricultural Research and Graduate Studies (SEARCA) since 1973 in the Social Laboratory Project which includes studies at ten villages near KKU.

With the assistance of the Asia Foundation, the Intensive Farm Training Program has been set up on the University Farm. In this program ten young farm families were moved to the KKU campus and given one year of training in intensive farming on a 0.3 ha. piece of land each.

The Faculty assisted the Office of Land Reform and the Department of Livestock Development, MOAC in planning, training and supervising 15 farm

families involved in an experimental small dairy farming project, approximately ten kilometers north of the KKU campus. The Animal Science Department of the Faculty, under the assistance of the Northeast Livestock Development Project of MOAC, has also been involved in reviving and improving backyard poultry in the villages in several provinces.

The Faculty is assisting in many training programs organized by the Department of Agricultural Extension, the Department of Community Development, the Department of Public Welfare etc. In addition, technical services such as soil testing are provided for farmers in the region.