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THAILAND

IRRIGATION PROJECT XI

STAFF APPRAISAL REPORT

November 26, 1979

Projects Department
East Asia and Pacific Regional Office

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CURRENCY EQUIVALENTS

Currency Unit - Baht (B)

\$1.00	-	B 20.0
B 1.00	-	\$0.05
\$1 million	-	B 20.0 million
B 1 million	-	\$50,000

WEIGHTS AND MEASURES

1 hectare (ha)	=	2.47 acres
1 kilometer (km)	=	0.62 miles
1 square kilometer (sq km)	=	0.386 square miles
1 meter (m)	=	39.37 inches
1 square meter (sq m)	=	10.76 square feet
1 cubic meter (cu m)	=	35.31 cubic feet
1 cubic meter per second (1 cu m/sec)	=	35.3 cubic feet per second
1 million cubic meters (MCM)	=	810.7 acre feet
1 millimeter (mm)	=	0.039 inches
1 kilogram (kg)	=	2.2 pounds

ABBREVIATIONS

ADB	-	Asian Development Bank
BAAC	-	Bank for Agriculture and Agricultural Cooperatives
cif	-	Cost, insurance and freight
DAE	-	Department of Agriculture Extension
EGAT	-	Electricity Generating Authority of Thailand
f.o.b.	-	Free on board
HYV	-	High-Yielding Variety
JICA	-	Japanese International Cooperative Assistance
MOAC	-	Ministry of Agriculture and Cooperatives
NESDB	-	National Economic and Social Development Board
O&M	-	Operation and Maintenance
RID	-	Royal Irrigation Development

THAI FISCAL YEAR

October 1 - September 30

THAILAND IRRIGATION PROJECT XI

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THAILAND

APPRAISAL OF THE IRRIGATION PROJECT XI

1. PROJECT BACKGROUND

Introduction

1.01 The Royal Thai Government has requested the Bank to assist in financing Irrigation Project XI. The proposed project would improve and extend existing irrigation facilities covering 66,000 ha in the Meklong Basin and provide new facilities to serve 15,000 ha in the Pattani Basin. Both project areas will be served by Bank-financed multipurpose dams, Ban Chao Nen (Ln. 977-TH) and Pattani (Ln. 1485-TH). The proposed project would allow effective utilization of water from these dams for year-round irrigation by improving and completing main canals, laterals, drains and on-farm development. Some 30,400 farm families would benefit from the improved water control and year-round cropping potential afforded by the project.

1.02 The project was prepared by the Royal Irrigation Department (RID) with the assistance of ILACO (Netherlands) and Sverdrup and Parcel International, Inc. (US). Feasibility studies carried out in the past for each of the project areas have been recently updated to reflect present conditions.

1.03 This report is based on the findings of a preappraisal mission in January/February 1979 comprising Mr. J.G. Stemp, Ms. N.K. Hill (Bank), Messrs. R. Campbell, C.G. Gonzales, J.W. Robins and P. Judd (Consultants) and an appraisal mission in April/May 1979 comprising Messrs. Stemp, Campbell and Robins.

The Agricultural Sector

1.04 Thailand's agricultural sector, contributing 30% of GDP, has been one of the most dynamic in Asia. Agricultural GDP grew at an annual rate of 5% between 1960 and 1977, and the sector continues to provide the largest part of the country's export earnings: 90% in the early 1960s, dropping to around 70% at present. It employs 75% of the country's labor force with employment growing annually at 1.5%.

1.05 Increases in the value of production have largely resulted from diversification into upland crops, including maize, sugarcane, cassava, tobacco and rubber, whose rapid production increase has offset the decline in cotton, coconut and other minor crops. Crop diversification has been mainly the result of additional land being brought under cultivation rather than crop substitution. While the area planted to paddy increased by about 2% p.a. from 1959-61 to 1973-75, the acreage under upland crops increased by more than 7% p.a. Paddy land as a proportion of total area under major crops, therefore, declined during this period from 71% to 64%. Land planted to rice accounted for 85% of total area in the North, 60% in the Central Region, and 76% in the Northeast.

1.06 Growth in agriculture has been the result of an active and flexible farming community which has responded to favorable world market opportunities and an effective and highly competitive marketing sector. For instance, in the 1950s, it was the outward-looking private sector that recognized new export possibilities for maize and kenaf and actively encouraged their production. From 1972/73 to 1975/76 when the price advantage of kenaf over cassava diminished, and kenaf acreage declined by 72%, rice and kenaf merchants in the Northeast quickly diversified into cassava drying and chipping, thus extending the crop from its traditional area in the Eastern Region. The private sector also participated in the world sugar boom (1973-75) by greatly expanding processing capacity into new production areas of western Thailand.

1.07 The public sector's contribution to agricultural development has been mainly in the provision of physical infrastructure, especially roads and irrigation facilities, and crop research, with particular emphasis on rice breeding. Nearly 60% of the public investment in agriculture, which has fluctuated between 7% and 10% of total Government expenditures, has been in irrigation development. Expansion of irrigation facilities has been a major factor in maintaining Thailand's comparative advantage in rice production, particularly through the construction of storage dams and major irrigation projects in the Chao Phya Basin. Road construction has provided access to new lands and has been the main stimulus for diversification into upland crops.

1.08 The potential for expanding the cultivable area, a major factor in the past growth of agriculture, has now been almost fully exploited and further growth must depend on more intensive use of existing farmland and higher yields. The area in agricultural use at present is about 20 million ha of which about 14 million ha is cropped annually (a cropping intensity of about 70%). Land use is already fairly intensive in areas devoted to corn and sugar cane, mostly in the Central Region where soils are generally of above-average fertility, but there is scope for higher yields. In the South, most of the good land for rubber is in use, but productivity could be increased by replanting with higher yielding varieties.

Irrigated Agriculture

1.09 Most of the irrigable areas in Thailand are in the flood plains of the major rivers where a combination of heavy rainfall and flooding precludes the cultivation of crops other than paddy in the wet season. In the Chao Phya Plain, heavy soils predominate and paddy is the preferred crop in the dry season as well. The situation is similar in the coastal plains in the south. Dry season cropping is more diversified on the alluvial soils of the Northern Region, and in the small areas so far developed for irrigation in the Northeast. In the wet season, the harvested area of rice averages about 7.7 million ha of which the irrigated areas account for some 1.8 million ha. Close to 0.5 million ha of rice is irrigated in the dry season. Since virtually all land suitable for rice is now cultivated in the wet season, any major gains in rice production will have to come from higher yields in both rainfed and irrigated areas, and increases in the area cropped in the dry season.

1.10 Throughout Thailand there are wide seasonal variations in river flows. In October, with the end of the Southwest monsoon, the river flows fall sharply and continue to decline until the beginning of the wet season in May. Year-round irrigation for intensive double cropping is, therefore, dependent on storage dams to conserve wet season runoff. Without storage, irrigation for a single wet-season crop is a viable proposition only on the large rivers with a reasonably dependable wet-season flow.

1.11 Until the 1960s, irrigation development in Thailand was concentrated in the area of greatest potential and highest level of economic development, the Chao Phya Basin, which covers large areas in the North and Central Regions. Major developments outside of the Basin in the last 15 years include the initial stages of a project to develop the Meklong Basin, second in size to the Chao Phya Basin; the construction of six large dams on the principal rivers of the Northeast region; numerous medium-scale schemes in the South and a start on development of the Pattani Basin. A brief historical review of water resource development in Thailand's major regions and river basins, and the contribution of Bank projects is presented below, followed by a look ahead at future possibilities for Bank lending for irrigation.

1.12 The Chao Phya Basin covers an area of some 180,000 sq km. Four northern tributaries, the Ping, Wang, Yom and Nan run together about 200 km north of Bangkok to form the Chao Phya. After following a single course for 60 km, the river splits into three branches which flow across the Chao Phya Plain to the Gulf of Thailand. There is a long tradition of irrigation on the small streams feeding the Chao Phya's northern tributaries where several thousand private schemes (People's Irrigation Projects) serve some 200,000 ha. The first large-scale water control projects were begun in the southern part of the Chao Phya Plain in the 1890s as private enterprises. In 1904, the RID was formed as the agency responsible for water resource development throughout Thailand. Although no longer responsible for hydroelectric development, which is now handled by the Electricity Generating Authority of Thailand (EGAT), RID is responsible for all irrigation in Thailand except for the People's Irrigation Projects in the North managed by farmers' groups. RID's first major undertaking was the completion of a network of navigation/drainage canals over 500,000 ha in the southern Chao Phya Plain, an area subject to deep and prolonged flooding. The canals were designed to spread the seasonal floods more evenly over the Plain and to provide access to large tracts of uncultivated land. RID later turned its attention to the construction of a gravity irrigation system of 600,000 ha in the northern Chao Phya Plain where drought is more of a constraint to rice production than floods. A key element in this system, the Chainat Diversion Dam, together with a number of major canals, was financed by the Bank in 1950 (Ln. 36-TH). This was the Bank's first loan to Thailand for irrigation development.

1.13 Since 1950, the Bank has been closely involved in development of the Chao Phya Basin's land and water resources. Of particular importance were the Bank-financed multipurpose dams on the northern tributaries; Bhumipol Dam on

the Ping completed in 1964 (Ln. 175-TH) and Sirikit Dam on the Nan completed in 1973 (Ln. 514-TH). These projects, which exploited the only two major reservoir sites in the Basin, have firmed up the wet-season flows and greatly increased water availability for dry-season irrigation. The projects are also major sources of hydroelectric power and energy. In the 1960s, it became apparent that higher standards of water control within the irrigated areas were needed to fully exploit the Basin's irrigation potential. The extensive mode of development followed by RID had been successful in providing vast areas with reasonable security against flood and drought risks for a low-yielding wet-season paddy crop. The Bank-financed "Ditches and Dikes Project" in 1963 (Ln. 328-TH), therefore, aimed to serve some 1.5 million ha with a simple system of tertiary canals. This was a considerable advance over the semi-controlled field-to-field flooding from the main and secondary canals. As new high-yielding rice varieties were introduced and rice prices began to rise, further improvements in water control became economically feasible. The Chao Phya Irrigation Improvement project, financed by the Bank in 1973 (Cr. 379-TH), pioneered on a large-scale (15,000 ha) an intensive mode of on-farm development comprising tertiary canals, drains, farm roads and land leveling. A follow-up project for 60,000 ha was financed in 1976 (Ln. 1468-TH). Another major Bank project in the Basin, the Phitsanulok Project (Ln. 1149T-TH), consists of a new system for 95,000 ha downstream of the Sirikit Dam; this is the first Bank-financed project in the Northern Region.

1.14 Nearly 1.3 million ha in the Chao Phya Basin benefit from water control works in the wet season. About 450,000 ha are now irrigated in the dry season, compared to less than 100,000 ha before the Sirikit Dam was completed. There is no further scope for increasing dry-season flows to the Chao Phya Plain since there are no additional large reservoir sites on the tributaries. However, improved efficiency of water use in both seasons would allow some increase in dry-season irrigation. There is also considerable potential for raising wet-season paddy yields through higher standards of on-farm development.

1.15 The Meklong Basin, situated immediately to the west of the Chao Phya Basin, covers an area of 27,700 sq km. The Meklong's two main tributaries, the Kwaie Yai and Kwaie Noi join together to form the main river, some 90 km from the sea. Construction of the first stage of a project which would eventually serve nearly 120,000 ha of the 400,000 ha Basin's irrigable land began in 1964 with Bank assistance (Ln. 394-TH). The extensive mode of irrigation development current in the 1960s was adopted for the first stage and in subsequent areas developed by RID. There were delays in selecting a site and in the decision to proceed with a dam on the Kwaie Yai. However, construction of the Bank-financed Ban Chao Nen multipurpose dam (Ln. 977-TH) began in 1974 and dry-season water became available in 1978. Construction of a dam on the Kwaie Yai, probably with Bank financing, is scheduled to begin in 1981. The stage is now set for a considerable expansion of year-round irrigation in the Meklong Basin which has by far the greatest potential for increased production of any of Thailand's river basins. To exploit this potential, major emphasis will be placed on on-farm development in conjunction with upgrading and extending the main irrigation and drainage systems.

1.16 The Northeast is poorly endowed with water resources; full control of the region's rivers would irrigate less than 10% of the 3.5 million ha of paddy land. The region is bordered by one of Asia's largest rivers, the Mekong, which forms the international boundary between Thailand and Laos. Several hundred thousand hectares could be irrigated from the Mekong if the Pa Mong Dam were built, but this would involve resettling over 300,000 people living in the reservoir area. In the 1960s, RID with bilateral assistance embarked on a major program of dam construction in the region. Six large dams and nearly 200 small dams were built, but there was a considerable time-lag between construction of the dams and subsequent construction of the irrigation system. In general, the systems were poorly designed and on-farm development was lacking. RID is now engaged in a program to improve irrigation systems downstream of the large dams with loans from various sources, including the Bank (Cr. 461-TH and Ln. 1630-TH). Completion of these works will bring year-round irrigation to 160,000 ha, more than half of the region's irrigation potential.

1.17 In the South, existing developments are concentrated on the east coast which has close to 90% of the region's 600,000 ha of rice land. About 75,000 ha are served by numerous projects consisting of diversion dams and canals. Some of these are still to be developed and the service area is expected to increase to about 95,000 ha. The main purpose of these diversion projects is to provide supplementary irrigation for the wet-season rice crop. Dry-season cropping is limited by the low flow of the rivers to about 10,000 ha, of which about one-half is paddy. About 45,000 ha in the low-lying coastal areas benefit from "conservation projects" which consist of drainage systems and control works to prevent salt water intrusion. Three large projects have been studied: two involve multipurpose developments of the Pattani and Ta Pi-Phun Duang River Basins, and a third would use the Songkhla Lake as a source of irrigation water. The total irrigation potential of the three projects is close to 160,000 ha. The most advanced is the Pattani project, which includes a dam and power plant on the Pattani River financed by a Bank loan in 1977 (Ln. 1485-TH).

1.18 A notable feature of Bank-financed irrigation projects in recent years has been the introduction of improvements in agricultural extension, such as the training-and-visit system, introduced in 1973 in the Chao Phya Irrigation Project. In 1976, the Government requested Bank financing for a National Agricultural Extension project which would cover 33 provinces. A loan for a second National Agricultural Extension project which will cover the remaining 39 provinces was recently approved.

1.19 In 1976, Bank staff undertook a review of the irrigation subsector at the request of the Government. As a starting point, estimates were made of the required increase in paddy production needed for Thailand to meet growing domestic demand and to maintain its share of the world market. It was estimated that production would have to increase from 15.1 million tons of paddy in 1976 to 22.7 million tons in 1990. Assuming a yield increase of

20% in rainfed paddy areas, irrigated paddy production would have to more than double from 5.5 million tons to 12 million tons. The review outlined a program to be carried out in the period 1977-90 to meet this demand. It comprises improvement of existing systems (710,000 ha), extension of existing systems (290,000 ha) and new projects (315,000 ha). Although this is an ambitious program, it should be noted that a start has been made on some major elements of the program such as the improvement of existing systems in the Northern Chao Phya and Northeast Thailand, and a major new project, Phitsanulok. Although the proposed program is reasonably well distributed between the four major regions, it should be noted that irrigation by itself has only limited scope for redressing regional income inequalities due to the need to select projects in areas with suitable soils, topography, water supply and production potential.

1.20 As a follow-up to this review, Bank staff has assisted RID and other government agencies in identifying in further detail individual projects, to be initiated in the period 1980-84 and which would be suitable for external financing. The proposed project is a direct outcome of this review, and further stages in the expansion of the Pattani and Meklong systems for some 100,000 ha are part of RID's 1980-84 program. In the Northeast, the program includes the Nam Mun project, consisting of two storage dams and new irrigation systems for 22,000 ha. Projects in the North would include a dam on the Yom River to irrigate nearly 70,000 ha and the Mae Kok project for some 20,000 ha. A nationwide medium-scale irrigation project is included (a first phase is now being prepared) to cover new projects and rehabilitation of existing schemes. A start would also be made on a number of schemes in the Bang Pakong Basin to the east of the Chao Phya Basin. Some of these projects are being prepared, and others will be prepared, with financing from current Bank loans for irrigation.

1.21 A program of the scale referred to in para. 1.19 presents a major challenge to RID's project implementation capacities. RID is organized in 22 functional divisions and 12 regional offices. In the past, fragmentation of project activities among various divisions and offices has caused serious coordination problems in project implementation, since no single individual or division has been responsible for seeing that a project achieves its primary objective of timely and reliable delivery of water to the farmers' fields. Progress has been made in overcoming this problem in Bank-financed projects by appointment of Project Managers with responsibilities for coordinating the inputs of the service divisions. In fact, there has been a steady improvement in RID's performance on Bank-financed projects in recent years. An important step towards assisting RID to strengthen its capacities to implement and manage its expanding workload, an Administration and Organization Study has been carried out by consultants financed under the Phitsanulok Project and is currently under review by RID.

1.22 In summary, since 1950, Bank assistance to Thailand's water resource development has included financing for four multipurpose dams and nine irrigation projects for a total of US\$446 million. Three of the loans for

multipurpose projects were to the EGAT, thus ten loans have been made to the irrigation subsector. Of these, six were for projects in the Chao Phya Basin, one for the Meklong Basin, two in the Northeast, and one for the Petchaburi project close to the Meklong Basin. The five projects undertaken since 1973 have incorporated the higher standards of water control mentioned above (para. 1.13). Project Completion Reports were prepared for the Siri-kit Dam (Loan 514-TH) and the Chao Phya Irrigation Improvement (Credit 379-TH) Projects. The former can be considered a highly successful project in that it made a major contribution to the rapid expansion of dry season cropping in the Chao Phya Basin and was a timely addition to the country's power sector. The Chao Phya Project was also successfully completed and has provided valuable experience to the Government in implementing an intensive mode of on-farm development. Implementation of current Bank projects is satisfactory, and good progress is being made in overcoming the procurement delays which affected some earlier projects.

Project Formulation

1.23 Meklong. In 1964, the Bank made a loan of US\$23 million for a first stage project in the Meklong Plain (Ln. 394-TH). The purpose of the project was to provide regulated wet-season irrigation, surface drainage, and partial flood control to 175,000 ha on the left bank (known as the Stage I area). The project also included land classification of the entire Meklong Plain (390,000 ha) and a feasibility study for a Stage II project. The feasibility study under Ln. 394-TH was completed by RID in 1968 with the assistance of advisers from the United States Bureau of Reclamation (USBR). In their report, RID proposed construction of a multipurpose dam on the Kwaie Yai and an irrigation, drainage and road system to serve the Stage II area.

1.24 Concurrently, the Electricity Generating Authority of Thailand (EGAT) prepared a proposal for a dam at a different site on the Kwaie Yai which was claimed to supply sufficient water for the irrigation development proposed by RID. The Government supported EGAT's proposal and in 1974, the Bank made a loan of US\$75 million for the Ban Chao Nen Hydroelectric Project (Ln. 977-TH). This project, scheduled for completion in 1981, will provide a regulated flow sufficient for double cropping on over 250,000 ha. Also in 1974, the Ministry of Agriculture and Cooperatives (MOAC) commissioned ILACO to further analyze the land use, crop production and performance of existing irrigation works and to review the plans for future development of irrigated agriculture in the Meklong area. This study, financed from funds provided for consultant services under Ln. 379-TH, was submitted to the Government at the end of 1974. Meanwhile, RID in 1970 began design and construction of the main canals and laterals to serve the Stage II right bank area.

1.25 In anticipation of the availability of dry-season water from the Ban Chao Nen Dam and eventually from the Khao Laem Dam where construction is to begin in 1981, the Government took further steps to accelerate development of the Basin. They arranged in 1977 for the Japanese International Cooperative Assistance program (JICA) to provide consultants, Sanyu, Inc. to

carry out a feasibility study for on-farm development of 50,000 ha in the Stage I area and also to prepare a Master Development Plan for the Meklong Basin. They also requested that the Chao Phya Irrigation Improvement Project II (Ln. 1468-TH) include funds for consultants to prepare a major project for high priority development in the Meklong irrigation area. RID retained ILACO, the consultants assisting in implementation of both Chao Phya Improvement Projects, to prepare this project. The Government, in consultation with the Bank and ILACO, determined that the project begun by RID in 1970, involving the completion of irrigation and drainage systems for the Stage II right bank area had the highest priority and would, moreover, not conflict with the JICA master plan scheduled for completion in 1980/81. To date, RID has constructed the main canals and laterals to serve about 43,000 ha out of a 66,000 ha service area. It is this project which the Bank has been requested to finance.

1.26 Pattani. Since 1963 various consulting firms and bilateral assistance agencies have carried out studies on the hydropower and irrigation potential of the Pattani River Basin. The current proposal for development of the basin, including a storage dam, power plant and phased irrigation of about 52,000 ha, is largely contained in a feasibility report for a multi-purpose project prepared for RID by Sverdrup and Parcel International, Inc. (SPI) in 1969. On the basis of their feasibility report, SPI was retained by EGAT in 1974 to prepare design and contract documents for the dam and power plant. A Bank loan of US\$50 million (Ln. 1485-TH) was made to EGAT in 1977 to assist in financing the storage dam and power plant. At the Bank's suggestion, RID requested SPI to update the irrigation proposals for the Stage I development of about 40,000 ha outlined in the 1969 report. This study, carried out by SPI in association with Frederiksen, Kamine and Associates (FKA) in 1977, and financed under the loan for the Phitsanulok Project (Ln. 1149-TH), forms the basis for the Pattani component of the proposed project. RID, in the meantime, awarded a contract for construction of the Stage I diversion dam and began force account construction of the right main canal to serve about 15,000 ha net. The diversion dam is scheduled to be completed in January 1980 and to date about 23 km of the right main canal have been constructed. The proposed Bank project would help to finance the completion of the right main canal, lateral canals, and secondary drains, and on-farm development for 15,000 ha, and detailed engineering for the remaining 30,000 ha.

2. THE PROJECT AREA

Location

2.01 The two components of the project, Meklong and Pattani, are located in the Central and Southern region, respectively. The Meklong project, on the right bank of the Meklong River about 100 km west of Bangkok (Map 14432), forms part of the Meklong River Basin, one of the largest river basins in Thailand. The project is bounded on the North and East by the Meklong River and by the provincial capital of Phetchaburi to the South. The Pattani project is located in Pattani province in the extreme south of Thailand, about 800 km from Bangkok (Map 14431). The service area forms part of the Pattani River delta situated in the coastal plain along the Gulf of Thailand. The provincial capital of Pattani, with a population of 31,000, is adjacent to the project area at the mouth of the Pattani River. Both areas are served by well-developed networks of provincial and district roads and are linked to Bangkok by main roads and railways. A good all-weather road extends from Pattani to Malaysia. Air and sea transport are also available from Pattani.

Climate

2.02 The tropical and monsoonal climate with its warm temperatures throughout the year provides a 12-month growing season in both project areas. The mean annual rainfall in the Meklong area is about 1,000 mm with about 85% occurring between May and October during the southwest monsoon. However, dry periods of up to ten days are not uncommon, especially in June and July, and wet-season rice frequently suffers significant yield reductions due to both late planting and periodic drought. In the dry season, irrigation is essential to ensure a rice crop.

2.03 The rainfall pattern in Pattani differs from that in Meklong. Pattani is affected not only by the southwest monsoon, which sweeps across the entire country, but also by the northeast monsoon. Mean annual rainfall is about 2,000 mm, with about 60% occurring between October and early January (the northeast monsoon). This is followed by a short dry season until the southwest monsoon begins in May. The southwest monsoon continues sporadically until October with about 30% of the annual rainfall occurring during this period. Rainfall is only sufficient for one rainfed rice crop during the main rainy season (September-January). Significant yield reductions frequently occur due to dry spells in September and January, and floods in November/December. Further climatic details are given in Table 2.1.

Topography and Soils

2.04 The Meklong service area is generally flat with the exception of terrace lands to the extreme west and the levee soils along the right bank of the Meklong to the east, where the topography is sometimes irregular with ridges and depressions. The land slopes gently from north to south and from west to east with a slight rise to the right bank levee of the Meklong, which

has created a natural depression. Flooding from the Meklong has been considerably reduced by the construction of the Ban Chao Nen (Srinagarind) Dam /1 on the Kwae Yai River and a flood protection dike on the upper portion of the right bank of the Meklong. The proposed Khao Laem Dam will further reduce overflowing.

2.05 The Pattani service area is flat to slightly undulating, sloping gradually from the mountain range along the southern boundary of the project with a gradient of about 1:1,500, flattening out at the midpoint of the service area to a gradient of about 1:3,000. There are some drainage problems in the area due to the generally flat topography and frequent flooding from the river in the wet season. However, flooding will be reduced on completion of the multipurpose dam being built upstream 45 km from the project area. Salt water intrusion is a problem in the lower part of the project in areas penetrated by tidal streams.

2.06 The predominant soils occupying about 75% of the Meklong project area are heavy clays of the Ratchaburi and Rangsit series which have a generally high nutrient status and are ideally suited to rice. Sandy loams of the Kamphaeng Saen and Tha Muang series occupy about 10% of the project area, mostly on the natural levees of the right bank of the Meklong. These coarser textured soils, presently planted to sugarcane are fertile and well-suited to a wide range of upland crops. Transitional clay loams, loams and silty loams occupy the remaining 15% of the project area. These soils, located between the levee soils and the lowland floodplains and along the western boundary of the project area, are suitable for both rice and upland crops.

2.07 Soils in the Pattani project area are a complex mix of riverine and marine alluvia. Medium-textured levee soils (clay loams) are found on higher ground, along old meandering stream beds and adjacent to the existing rivers. These soils, which occupy about 25% of the cultivable area of the proposed project, are planted with upland crops, mostly tree crops of rubber, coconut and fruit trees. Irrigation development in the proposed project area is confined to the lower lying basin soils. There are medium-to-heavy kaolinitic clays, slightly to moderately acid with poor internal drainage. These soils are well suited to rice which is grown exclusively throughout the area to be developed. Saline soils are found along the Nam Sai River as a result of saline intrusion. Under the project, salinity will be reduced through the provision of year-round irrigation, adequate drainage and the installation of tidal gates.

/1 At the time of Bank appraisal, the dam was called Ban Chao Nen; since then it has been renamed Srinagarind. To maintain consistency with existing Bank documents, the original name is retained in this report.

Table 2.1: CLIMATE DATA

Item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
<u>Meklong</u>													
Average rainfall- mm	4	12	20	54	131	116	122	131	235	206	64	10	1,105
No. of rainy days	1	1	2	3	9	10	11	10	14	10	4	1	76
Temperature - mean °C	25	28	30	31	30	30	29	29	28	28	26	25	28
Mean maximum	32	35	37	38	36	34	33	33	32	31	31	31	
Mean minimum	18	21	23	25	25	25	24	24	24	24	21	18	
Relative humidity %	64	65	62	62	69	70	73	75	80	80	75	68	
<u>Pattani</u>													
Average rainfall - mm	112	13	33	36	118	111	119	115	142	322	556	468	2,145
No. of rainy days	5	2	2	2	6	6	6	6	8	11	14	12	80
Temperature mean °C	27	27	28	29	28	28	28	28	27	27	27	27	27
Mean maximum	33	35	36	36	37	35	35	35	35	35	34	33	
Mean minimum	19	19	19	20	21	21	21	20	20	22	20	20	
Relative humidity - %	77	78	77	78	78	78	77	77	78	82	84	82	

Farm Size and Land Tenure

2.08 There are about 30,400 farm families in the two project areas, 21,500 in Meklong and 8,900 in Pattani. With an average family size of six in Meklong and eight in Pattani, the total population is about 200,000. The average farm size in Meklong is about 3.3 ha. Approximately 50% of the Meklong farmers are owner-operators and a further 40% are landowners who rent additional land from other farmers. Only 10% are tenant farmers who operate under various share, cash and labor exchange arrangements.

2.09 In Pattani the average paddy holding is about 1.8 ha. Virtually all of the farmers own at least part of their land but small farmers frequently rent a portion of their holdings from large landowners in the area. There are very few individually operated rice holdings in excess of 3 ha. In addition to their paddy holdings, the larger farms have some land under rubber, most of which is located outside the project area. The farm size distribution in Meklong is based on independent surveys conducted by consultants (ILACO), a Thai university consortium (1974), and RID (1975), and in Pattani on data from selected villages. Details for both project components are given in Table 2.2.

Table 2.2: FARM SIZE DISTRIBUTION

Farm size (ha)	Farms		Project Area	
	No.	(%)	(ha)	(%)
<u>Meklong</u>				
<1.0	1,500	7	900	1
1.1-2.0	3,000	14	4,500	6
2.1-3.0	6,500	30	16,250	23
3.1-4.0	4,300	20	15,250	22
4.1-5.0	3,000	14	13,500	19
>5.0	3,200	15	20,600	29
	<u>21,500</u>	<u>100</u>	<u>71,000</u>	<u>100</u>
<u>Pattani</u>				
<1.0	2,250	25	1,200	8
1.1-2.0	3,800	43	5,700	36
2.1-3.0	1,500	17	3,750	23
3.1-4.0	500	6	1,750	11
4.1-5.0	450	5	1,500	9
>5.0	400	4	2,100	13
	<u>8,900</u>	<u>100</u>	<u>16,000</u>	<u>100</u>

Existing Irrigation Facilities

2.10 Meklong. The Vajiralongkorn Diversion Dam on the Meklong River about 14 km downstream from the town of Kanchanaburi (see Map No. 14432) diverts water for wet-season irrigation of about 27,000 ha in the upper part of the project area. The dam was completed in 1970 under the Meklong Stage I project with assistance from Ln. 394-TH. RID began construction of a main irrigation and drainage system in the project area in 1970. To date two main canals (1R and 2R) totaling 157 km have been built, together with 248 km of laterals and 65 km of drains. Most of the 90 km of 1R canal and 12 km of the 2R canal are concrete lined. O&M roads have been constructed along the mains and laterals but are in need of some improvement. About 860 km of farm irrigation ditches have been constructed under RID's "ditches and dikes" program covering about 33,000 ha. However, 20-30% of the area is uncommanded; the ditches are generally in a poor state of repair and afford very little water control.

2.11 Pattani. Irrigation water would be supplied from an existing diversion dam on the Pattani River at Kurat, about 15 km downstream from the provincial capital of Yala. The dam is designed to divert water to a right, center and left main canal to serve a net irrigable area of about 45,000 ha. The first 1.5 km of main canal from the headworks to the bifurcation of the right and center main canals is now under construction. The next 23 km of right main canal, including about 10 km with concrete lining, have been completed but without checks or turnout structures. Parts of the lined section, installed in 1972, are broken and the entire area is in a poor state of repair. No laterals have been constructed in the project area. RID has completed 6 km of a 17 km main drain in the lower part of the project area. Other drainage facilities are limited to natural water courses plus some small ditches constructed by the farmers. Dikes have been constructed on each side of the river upstream of the diversion dam to retain the pool created by the dam.

3. THE PROJECT

Project Description

3.01 The project would provide for construction of new irrigation facilities and improvement of existing facilities to irrigate 66,000 ha in Meklong and 15,000 ha in Pattani. The main features would be:

Meklong

- (a) improvement and enlargement of 157 km of the existing main canal and completion of 33 km of new main canal;
- (b) improvement and enlargement of the 206 km of existing lateral canals and construction of 103 km of new lateral canals and service roads;
- (c) completion of about 336 km of main and secondary drains; and
- (d) construction of tertiary canals, drains and farm roads;

Pattani

- (a) improvement of 23 km of the existing right main canal and construction of the remaining 25 km;
- (b) construction of about 134 km of laterals and service roads;
- (c) construction of about 165 km of main and secondary drains; and
- (d) construction of tertiary canals, drains and farm roads.

3.02 In addition, the project would provide construction equipment, operation and maintenance equipment, buildings, and consulting services to assist in the design and implementation of project works and detailed engineering for the 30,000 ha remainder of the Pattani Stage 1 development.

Project Works

3.03 Meklong. Rehabilitation works are required to upgrade the existing irrigation, drainage and road systems (para. 2.10) to enable efficient operation and to maximize water availability in the dry season. The 1R canal, originally constructed with a design capacity of 66.9 cu m/s, would be enlarged to 85.2 cu m/s to supply a service area of 50,700 ha with irrigation in the dry season. This would be accomplished by raising the concrete lining 0.40 m in the initial 17.4 km, installing concrete lining in 8 km of the presently unlined section, and cleaning and reshaping 11 km of unlined section. The capacity of the remainder of the existing canal is adequate. Cross-drainage structures would be installed to bypass flood flows from the western catchment area across the 1R canal. The upstream spoil bank would be shaped to provide

a training dike for routing the flood flows into the cross-drainage structures. The remaining 33 km of the 1R canal (km 90 to 123) would be constructed to serve the lower part of the project area. The existing 2R canal capacity would be increased from 13.7 to 25.5 cu m/s and would provide full irrigation to 14,000 ha in the dry season. A supplemental intake structure would be installed at the headworks, the initial 8 km of canal would be widened and the lining replaced on the lower bank. The lining would be raised 0.60 m in the remaining 4 km of lined section, and the width and depth would be increased in the 55 km of unlined section.

3.04 About 206 km of existing laterals would require enlargement and rehabilitation to deliver the required peak demand at the farm level in the dry season. About 30% of these laterals would be lined in areas where excessive seepage losses and erosion appears likely. The remaining 41 km of existing laterals and the 65 km of existing drains are adequate. About 103 km of new laterals and 336 km of drains would be constructed. Service roads along main and lateral canals and main drains would be 5 m wide and paved with a 20 cm laterite surface.

3.05 The proposed type of on-farm development would be similar to that being implemented in the Northeast Irrigation Project Stage I (Cr. 461-TH) and "Class B" areas in the Phitsanulok Project (Ln. 1149T-TH). Tertiary canals would be provided to serve units of about 60 ha. The maximum area served from one farm turnout would be 4 ha and all farmers would have direct access to irrigation water and drains. Farm roads, 3 m wide, would be provided along about 70% of the tertiaries which, together with service roads along laterals and drains, would provide all farmers with direct access to a road system. A minimum amount of boundary realignment would be necessary. Rough leveling only in the vicinity of the new facilities and boundaries would be provided; any final leveling necessary would be the responsibility of the farmers. Paddy land over most of the project area is reasonably level, plots are generally large and level, and there is little fragmentation of holdings. Studies of sample areas show that a rational layout of tertiary canals, drains and farm roads can be achieved without recourse to the intensive land consolidation adopted in the Chao Phya Irrigation Improvement Project.

3.06 Pattani. The first 23 km of the right main canal would be repaired and cleaned, and water regulating and delivery structures installed. The remaining 25 km of the right main canal would be constructed without lining except for about 2.5 km which passes through an area of permeable soils. Eight main lateral turnouts with head regulators, plus a number of small farm turnouts and minor structures would be provided in the new section.

3.07 The project would provide for the construction of about 134 km of laterals which would be unlined except for about 15% which pass through areas where excessive seepage and water loss appears likely. Service roads would be constructed along the main canal and laterals. About 165 km of drains would be constructed in the project to accelerate surface runoff during and after floods. Tide gates would be provided in drainage channels emptying into the sea to limit saline intrusion.

3.08 Paddy lands in the project area are generally level but fragmented and interspersed with rubber trees, coconut palms, and orchards, mostly owned by the paddy farmers. Project staff have found little support among the farmers for any significant rearrangement of paddy holdings. On-farm development would be similar to that adopted for Meklong and the average size of each tertiary unit would be about 60 ha. It would not be feasible, however, to provide each farmer with direct access to ditches and drains, and some field-to-field irrigation and drainage would be necessary. Also, to minimize encroachment on farm holdings, roads would be constructed only along some 30% of the total length of the tertiary canals.

Water Supply, Demand and Quality

3.09 Meklong. The Meklong River has a catchment area of 25,600 sq km above Vajiralongkorn diversion dam with a mean annual runoff of about 12,500 MCM, of which the Kwaie Noi contributes about 50%, the Kwaie Yai 40%, and other tributaries 10%. With the completion of the Ban Chao Nen and the Khao Laem Multipurpose Dams, by 1985 about 8,860 MCM of regulated flow would be available to meet the requirements at Vajiralongkorn diversion dam. Water requirements for domestic and industrial uses, salinity and pollution control, and navigation have been estimated at 1,600 MCM annually. The remaining 7,260 MCM would be available for irrigation in the Meklong area. Extensive sampling and detailed chemical analyses have shown the water of the Kwaie Yai and Kwaie Noi to be of excellent quality for sustained irrigation.

3.10 Irrigation demands for the project area were calculated for the cropping patterns described in Chapter 5 and the crop calendar shown in Figure 5.1. Irrigation requirements for land preparation and crop growth (consumptive use minus effective rainfall plus percolation loss) were calculated on a monthly basis using appropriate crop factors. Planting periods of 42 days for rice and 5 months for sugarcane were assumed. Percolation losses for rice were assumed at 1 mm/day during the dry season and 0.5 mm/day in the wet season. The net annual irrigation requirements amount to about 860 MCM for 61,000 ha of doubled cropped rice, and 80 MCM for 5,000 ha of sugarcane. The diversion requirement was determined by applying the following efficiency factors:

	<u>Rice</u>	<u>Sugarcane</u>
Main canals and laterals	80%	80%
Farm efficiency	75%	70%
Overall efficiency	60%	56%

Annual irrigation diversion requirements would be about 1,500 MCM, or about one-fifth of the available regulated flow.

3.11 Pattani. Water supply for the project would be obtained from rainfall and the controlled discharge from the Bang Rang Dam on the Pattani River (Ln. 1485-TH) which is due to commence operation in 1981. Reservoir operation studies have been carried out by EGAT to assess the capability of the reservoir to meet irrigation demands for a net irrigable area of

45,000 ha. Monthly inflows for a period of 15 years (1962-77), supplemented by correlating runoff with rainfall records for the periods 1922-58 and 1952-65, were used in the study. Sampling and analyses at the diversion site indicate the water is of good quality for sustained irrigation.

3.12 The irrigation water demand for the project was calculated for the cropping patterns described in Chapter 5 and the crop calendar shown in Figure 5.2. Irrigation water requirements were determined in the same manner as described for the Meklong project and the same irrigation efficiencies were assumed in calculating diversion requirements. EGAT's operation studies showed that with development of the full 45,000 ha in Pattani Stage I area with a 170% cropping intensity, irrigation shortages would be confined to the dry season and would occur in only 15 months of the 300-month study (1952-76). Shortages would range from 5% to 10% of the dry-season demands and in many years the supply would be adequate for an 80% dry-season cropping intensity. In practice, it would be possible to forecast the seasonal water supply available for irrigation from reservoir levels at the beginning of the dry season and anticipated stream flows. Farmers would be advised at that time on the proportion of land to crop for the season. Given that shortages would be predictable and could be managed by predetermined cropping plans, a higher long-term cropping intensity than 170% may be attainable. However, in view of the relatively short period covered by the runoff records used in the operation studies, an annual intensity of 170% has been used for project evaluation. Further details on irrigation water requirements for both project areas are shown in Annex 2.

Status of Design

3.13 The canal and drain alignment for both projects and designs of existing facilities were based on 1:10,000 scale maps prepared in the late 1960s. RID's Survey Division is now resurveying both project areas and new 1:4,000 scale maps will be prepared for on-farm development designs and for detailed designs of canals and drains. Existing designs will be checked using the new maps. Mapping for the 15,000 ha served by the right main canal of Pattani will be completed in 1979 and for the remaining 30,000 ha in 1980. Mapping for 66,000 ha of Meklong will begin at the end of 1979 and will be completed in 1982. In recent years, the Survey Division has greatly improved its survey and mapping capability by using up-to-date techniques introduced with the help of a Survey Adviser, whose services have been financed under previous Bank projects.

3.14 RID has completed designs for the right main canal of Pattani, and the remaining 33 km of the 1R canal of Meklong. Detailed designs have also been completed for the laterals and drains to be contracted in the 1980 working season. Designs for most of the new laterals and drains to be constructed as well as 75% of the on-farm development works will be carried out by consultants beginning in early 1980. RID's Design Division will prepare designs for the rehabilitation works in the canals and laterals, and 25% of the on-farm works.

Project Implementation

3.15 The Meklong project would be constructed over a six-year period starting in 1980 with rehabilitation and completion of the 1R canal (Figure 3.1). At the same time work would start on laterals and drains in the upper part of the service area. Enlargement of the 2R canal and on-farm development would be started by force account in the second year. Contract work on on-farm development would start in the third year. Work on laterals, drains, and on-farm development would progress from the upper to lower part of the area and be completed by the end of the sixth year. Irrigation water deliveries would be initiated in the second year on a block of 4,000 ha. Thereafter, additional blocks would be completed each year, with full irrigation of the project area in the seventh year. With this approach incremental irrigation benefits would begin to accrue during the construction period as investments are made.

3.16 The Pattani project would be constructed over a five-year period starting with rehabilitation of the existing 23 km of the right main canal in 1980 (Figure 3.2). At the same time work would start on construction of laterals and drains in the upper part of the service area. Construction of tertiaries for the first block of 2,000 ha would begin in January 1981. Thereafter, on-farm development would proceed in parallel with the construction of laterals and drains.

Cost Estimates

3.17 Total project costs in January 1980 prices are estimated at US\$186 million with a foreign exchange component of US\$80 million, or 43% of the total cost. Construction costs are based on quantity and unit price estimates prepared by RID and include about 10% for taxes and duties. Unit prices are in line with recent bid prices for similar work in Thailand updated to January 1980. Details of the cost estimates for the major work items are shown in Annex 1. Physical contingencies of 15% have been added to all civil works costs. Estimated price increases were derived by applying the following annual rates of price escalation.

	1980	1981	1982	1983	1984	1985
Civil works	10	10	9	8	7	7
Equipment & services	7	7	7	6	6	6

The rates used for civil works reflect the expected rate of price increases for local costs and the rates for equipment and services, which have a large direct foreign exchange element, are in line with expected international price increases. Expected price increases amount to US\$37.2 million, or 25% of base cost plus physical contingencies. A summary of project costs is given below:

Table 3.1: COST SUMMARY

	Local ---- (B million)	Foreign (B million)	Total ----	Local --- (US\$ million)	Foreign (US\$ million)	Total ---	% F.E.
Civil works	1,064.7	768.9	1,833.6	53.3	38.4	91.7	42
Equipment	15.2	272.7	287.9	0.7	13.8	14.5	95
Buildings	24.0	6.0	30.0	1.3	0.2	1.5	20
Right-of-way	195.9	-	195.9	9.8	-	9.8	0
Consulting services & training	46.7	65.9	112.6	2.3	3.4	5.7	58
Engineering & administration	203.7	35.4	239.3	10.1	1.8	11.9	15
Base cost	1,550.4	1,148.9	2,699.3	77.5	57.6	135.1	43
Physical contingencies	153.3	121.8	275.1	7.6	6.1	13.7	44
Price increases	419.8	325.3	745.1	20.9	16.3	37.2	44
<u>Total</u>	<u>2,123.5</u>	<u>1,596.0</u>	<u>3,719.5</u>	<u>106.0</u>	<u>80.0</u>	<u>186.0</u>	<u>43</u>

Financing

3.18 The Bank loan of US\$80.0 million would finance the foreign exchange requirement of the project. The Government's contribution of US\$106.0 million (B 2,123.5 million) would finance the balance of project costs through annual budgetary allocations to RID. The loan would finance retroactively an amount of \$350,000 for expenditures incurred since September 1, 1979 for a contract awarded by RID for extension of the right main canal at Meklong (para. 3.20).

Procurement

3.19 A major part of the project's civil works would be carried out by contract in line with RID's current policy of reducing the share of its construction program carried out by force account. Construction of all new canals, most of the laterals and about 75% of the on-farm works would be carried out by contract. Force account would be employed for most of the drains and particularly for those works where construction needs to be coordinated with operation of the existing system. Table 3.2 shows the expected division of work between contract and force account.

Table 3.2: CONTRACTS AND FORCE ACCOUNT

	Contract (including contingencies) ----- (US\$ million) -----	Force account -----
<u>Meklong</u>		
IR canal & lateral construction	18.0 (3)	2.0
Drain construction	6.5 (5)	8.0
On-farm development	43.5 (17)	12.0
IR canal rehabilitation	1.5 (1)	4.0
2R canal rehabilitation	0.5 (1)	1.5
Lateral rehabilitation	6.5 (2)	2.0
Buildings	1.0 (2)	-
<u>Pattani</u>		
RM canal & lateral construction	14.0 (2)	-
Drain construction	3.5 (2)	6.8
On-farm development	5.5 (3)	1.2
RM canal rehabilitation	1.0 (1)	1.5
Buildings	1.0 (2)	-
<u>Total</u>	<u>102.5 (41)</u>	<u>39.0</u>

3.20 The value of civil works contracts would range between US\$0.5 million and US\$7.0 million (including physical contingencies and expected price increases). Construction of the main canals and laterals would be packaged into contracts of not less than \$5.0 million and these would be awarded following international competitive bidding according to Bank Group guidelines. An exception would be a contract already awarded by RID following local competitive bidding (LCB) under procedures acceptable to the Bank. The size and phasing of contracts for construction of drainage systems and on farm works are dictated largely by the rate at which mapping, detailed designs and specifications can be prepared and right-of-way obtained. Also on-farm works need to be coordinated with the construction of laterals and drains and scheduled to permit farmers access to their land at least during the wet season; these works would be carried out in blocks of about 3,000 ha. Experience in Thailand has shown that contracts of this size are of little interest to international contractors. Therefore, these contracts would be awarded following competitive bidding in accordance with local procedures. Contracts would be advertised in Thai and English in the local press and documents would be in English. Foreign firms would, however, be eligible to bid. RID's local contracting procedures which have been followed on several Bank-assisted projects to date, are satisfactory. Bid evaluation procedures for LCB would follow Chapter III of the Bank's Guidelines for Procurement.

3.21 Vehicles and equipment (US\$15.8 million including expected price increases) would be procured following international competitive bidding (ICB) in accordance with the Bank's Guidelines. A 15% preference margin, or

the prevailing customs duty if lower, would be extended to local manufacturers in the evaluation of bids. Vehicles and equipment costing less than US\$20,000 each and limited to a total of US\$300,000, which are not practicable for international tendering, would be purchased through normal government procurement procedures (local competitive bidding or competitive quotations) which ensure adequate competition.

Disbursements

3.22 Disbursements from the Bank loan would be made at the rate of 100% against the foreign exchange cost of directly imported vehicles and equipment, or the ex-factory price net of taxes for items manufactured locally, and at a rate of 65% of total costs for imported items procured locally. For consultants' services, disbursements would equal 100% of total expenditures. Disbursements for civil works would be at 50% of total contract expenditures, to be disbursed against periodic contractors' progress payments. In the case of onfarm development carried out by force account, disbursement would be at the rate of US\$270/ha for Meklong and US\$140/ha for Pattani. These are the fixed rates agreed on by the Bank and RID, representing 50% of expenditures excluding depreciation of the equipment procured under the project, to execute on-farm development works. Disbursements for on-farm development would be made against certificates of completed work. This procedure is discussed in Annex 5. It is expected that disbursements would be completed by June 30, 1986. Estimated schedules of expenditures, disbursements and the proposed allocation of the proceeds of the loan are presented in Annex 1.

Project Cost Accounting

3.23 RID will maintain accounts in sufficient detail to record all expenditures for force account construction and payments to civil works contractors, equipment suppliers and consultants. RID's annual progress report will show these expenditures, both annual and cumulative, separately for the Meklong and Pattani components. For civil works, the expenditures will be broken down according to the major elements of the irrigation systems, such as main canals, laterals, drains, tertiary systems, etc. A suitable format for the project accounts was agreed with the Bank during negotiations.

Environmental Effects

3.24 The project would have a beneficial effect on the environment by providing a year-round water supply in an area presently dependent on uncertain rainfall. Its adverse effects would not be significant. The project areas are already flooded for paddy cultivation for about six months every year so that double cropping would not greatly increase the farmers' exposure to waterborne diseases or malaria. The canals would not be used for drinking water since the villagers rely on wells and rainwater for domestic use. Schistosomiasis is not present in the project area. A major emphasis in Thailand's rice-breeding program is to produce disease- and pest-resistant varieties; therefore, chemicals to control pests and diseases are used sparingly by Thai farmers.

4. ORGANIZATION AND MANAGEMENT

The Royal Irrigation Department

4.01 The Royal Irrigation Department (RID) would be responsible for project implementation. RID is now organized in 22 functional divisions and 12 regional offices, under a Director-General (Figure 4.1). Three Deputy Directors General and two Chief Engineers assist the Director General in the management of the Department. RID, together with most of the agriculture-related government agencies, falls under the Ministry of Agriculture and Cooperatives (Figure 4.2).

4.02 For recent Bank-financed irrigation projects, RID has adopted a system of project management which is aimed at placing all aspects of project implementation under the control of a Project Manager, who reports to a Project Director. A similar system would be adopted for the proposed project. Each of the two project components would have a Project Manager responsible for day-to-day management and for coordination with the consultants, the functional divisions, and other government agencies. The Project Managers both of whom have already been appointed, would report to the Chief of RID's Construction Division, who in turn reports to the Deputy Director General (Construction). Work in each of the project areas would be under the supervision of a Project Engineer. RID also plans to establish in the near future a Loan Projects Unit to assist the project managers and the functional divisions in coordinating the implementation of all externally financed irrigation projects. This would formalize an existing arrangement in which certain RID staff have routinely handled, in the case of externally financed projects, such matters as procurement, disbursements, reporting, administration of consultants, and coordination with the Ministry of Agriculture and Cooperatives.

4.03 An Administration and Organization Study carried out by consultants financed under Loan 1149-TH has recently been completed. The consultants' report has been reviewed in detail within RID and RID plans in the near future to take steps to begin implementing the consultants' recommendations. The consultants' recommendations would retain the existing organization along functional lines but would provide a more logical grouping of the different branches and a clearer definition of responsibilities of the Deputy Directors General and Chief Engineers. The consultants also recommend improvements in **planning and budgeting** and a closer monitoring of the implementation and impact of irrigation projects.

Consulting Services

4.04 RID would retain consulting firms, composed of foreign specialists in association with local consultants, to assist in the layout and design of project features, preparation of design and contract documents, supervision of construction, and the establishment of operation and maintenance programs. RID would also employ consultants to assist in setting up a monitoring and evaluation program. The estimated consultant input for Meklong would be about 150 man-months of expatriate staff and 500 man-months of local engineers and staff. The consultants for Pattani, in addition to assisting RID in implementation of the project, would prepare layout and designs for project facilities to serve the remaining 30,000 ha in the Stage I area. The estimated

consultant input would be 100 man-months of expatriate staff and 350 man-months of local engineers and staff. The estimated cost of expatriate staff, including travel and expenses, would average US\$9,000 per man-month. An assurance was obtained that consultants engaged by RID for project implementation and design would be employed on terms and conditions acceptable to the Bank.

Agricultural Supporting Services

4.05 Extension. The Department of Agricultural Extension (DAE) is primarily responsible for providing agricultural advice to farmers in the project areas. The extension services of DAE are currently being expanded and strengthened under a country-wide program in two phases. The National Agricultural Extension Project I (Ln. 1393-TH) started in 1977 and is due to be completed in 1981. The second phase project has been appraised and is scheduled to start in 1980. These projects will provide one extension agent for every 1,000 farm families with technical backstopping from subject matter specialists. Farmer groups in irrigation areas will be based on the tertiary service unit as opposed to the tambon in rainfed areas. Field extension activities will be closely coordinated with the activities of RID's O&M staff (para. 4.11). The program is already operative in the Pattani project area. Only part of the Meklong project area is covered by the ongoing National Extension Project, however, the entire project area is due to be covered by 1981 under the Second Phase project.

4.06 Research. The Pattani and Ratchaburi Rice Experiment Stations are located immediately adjacent to the Pattani and Meklong project areas. These stations are supported by the main regional rice stations for the Southern and Central regions at Khuan Khud and Suphanburi. Experimental work is focussed on varietal screening, fertilizer trials and seed multiplication. In addition, RID runs a small experimental station at Pattani. Both areas are adequately provided with information on the current technology of rice cultivation.

4.07 Fertilizers. At present little fertilizer is used in the project except for the small area of sugarcane at Meklong; annual fertilizer consumption amounts to about 4,400 tons. A wide variety of straight and compound fertilizers are used, although ammonium phosphate (16:20:0) is by far the most common fertilizer used on rice. Application rates are, on average, only about 30 kg/ha. At full development the project would require about 35,000 tons of fertilizer annually, of which 32,000 tons would be needed in Meklong and 3,000 tons at Pattani. Ammonium phosphate would account for nearly 70% of the total requirements and urea for 24%. Sulphate of ammonia, triple superphosphate and muriate of potash for use on sugarcane would make up the remaining 6%. Commercial channels for the distribution of fertilizers are well established in both project areas and private dealers and storekeepers would have no difficulty in meeting the demand.

4.08 Seeds. At full development the project would use approximately 6,300 tons of rice seed per annum, of which about 85% would be of high-yielding varieties. Assuming that rice seed would be replaced every six crops, the estimated annual seed requirement at full development would be 855 tons for Meklong and 190 tons for Pattani. The Ratchaburi and Pattani

Rice Experiment Stations would supply foundation seed to selected seed growers under the supervision of the Seed Multiplication Division of DAE.

4.09 Credit. The use of credit from institutional sources has increased recently in both Meklong and Pattani project areas. However, under existing rainfed conditions with the low use of inputs, the demand for production credit is low. At present, institutional sources account for 30% and 15% of total short-term production borrowings in Meklong and Pattani, respectively. With the development of irrigation, the demand for short-term credit is expected to increase from about B 34 million at present to B 300 million at full development. The Bank for Agriculture and Agricultural Cooperation (BAAC) would be the main source of institutional credit. BAAC has branch offices in all districts covered by the project area. An Agricultural Credit Project, aimed at strengthening BAAC, has been prepared for Bank financing. An assurance was obtained that BAAC would make available the additional staff and funds needed to meet the credit requirements of the farmers in the project area.

Operation and Maintenance

4.10 RID would be responsible for the operation and maintenance of the irrigation system down to the farm turnouts, the service roads, and the main and collector drainage system. Consultant assistance would be provided to assist RID in developing O&M procedures for the project. An amount of US\$2.0 million would be provided in the loan for the purchase of O&M equipment to strengthen RID's capacity for O&M work (Annex 1, Tables 8 and 9). The annual cost of operating and maintaining the project facilities for which RID would be responsible is estimated at US\$15/ha on average.

4.11 Operation and maintenance of the systems below the farm turnout would be the responsibility of the farmers, who would form water users' associations. RID, with consultant assistance, would promote the establishment of the water users' associations and provide them with technical assistance. The farmers in each group would elect a group leader and a common irrigator who would be responsible for operating the on-farm works and for ensuring that maintenance is carried out. RID would coordinate the activities of its O&M staff with those of the field extension staff of DAE. One set of farmers' groups based on the tertiary service unit would be used for both water management and extension purposes. Joint visits by O&M personnel and extension workers would be regularly scheduled to advise farmers on irrigation and cropping schedules and operation and maintenance of on-farm irrigation and drainage systems. The annual cost of O&M of the on-farm works is estimated at US\$4/ha.

Monitoring and Evaluation

4.12 RID would be responsible for monitoring and evaluating the project's costs, impact and economic benefits. To date, RID has relied heavily on the assistance of consultants and other government agencies to carry out monitoring of ongoing projects. Arrangements have varied from project to project, and there has been a lack of continuity and limited involvement of RID staff.

Recognizing the advantages of a properly organized in-house monitoring unit as a tool of management, RID wishes to strengthen its monitoring and evaluation capability. The Irrigated Agronomy Branch of RID's O&M Division is engaged in the routine collection of crop statistics for all irrigation projects, and the Economics Branch of RID's Planning Division undertakes agro-economic baseline surveys. Under the proposed project, consultants would be provided to assist RID in developing the capacity of these two units to undertake monitoring. An assurance was obtained that RID would not later than December 31, 1980, submit to the Bank for review and comment their detailed proposals for monitoring and evaluation of Bank-financed irrigation projects.

5. AGRICULTURAL PRODUCTION

Present Cropping Patterns

5.01 In Meklong about 65,000 ha of rice and 6,000 ha of sugarcane are cultivated in the wet season. In the upper part of the project area, about 27,000 ha of the rice crop and most of the sugarcane, receive some irrigation in the wet season from the existing system. Some 5,000 ha of the remaining rainfed paddy area is subject to flooding in the wet season due to impeded drainage; this area is planted in November after the flood waters recede, and harvested in March/April. Dry-season cultivation is limited to about 3,500 ha of pump irrigated rice. Virtually all rice is transplanted from field nurseries onto previously puddled land. Unreliable rainfall at the start of the wet season frequently causes delays in the planting program and transplanting takes place from June through September. The crop is harvested between November and January. Dry-season rice is grown between February and June, with transplanting in February/March and harvest in May/June. Photosensitive, local improved varieties (nonglutinous) are grown throughout the project area in the wet season. High-yielding varieties are grown only on the small area cropped in the dry season. Sugarcane planting is restricted to the period April-June, to correspond with the start of the rainy season. Harvest of the plant crop takes place during the dry season between December and April, and consequently the first crop is taken in less than 12 months, resulting in low yields and sugar content.

5.02 About 85% of the cultivable land in the Pattani project area is planted to a single rainfed rice crop grown in the wet season between August and March. The remainder, located on higher ground, is planted with tree crops, mostly rubber, with some coconuts and fruit trees. Virtually all rice is transplanted from field nurseries onto previously puddled land. Photosensitive, long-strawed, local varieties are grown throughout the project area.

Future Cropping Patterns

5.03 In the absence of the project in Meklong, there would be a gradual increase in the area of HYVs planted in the wet season up to about 20% of the total rice area, and in the dry season the cropping intensity would increase from the existing 5% to about 18%. Further increases in the dry season would be constrained by the inadequacies of the existing irrigation facilities. With the project, 66,000 ha would be provided with irrigation in the wet season and the dry-season paddy crop would increase from 3,500 ha to 55,000 ha. HYVs would be planted on about 75% of the area in the wet season and 100% in the dry season. With improved drainage, double cropping would be introduced on the 5,000 ha presently subject to floods (para. 5.01). The cropping intensity (excluding sugarcane) would increase from the existing level of 105% to 190%. About 1,000 ha of low-lying land currently planted with sugarcane would convert to paddy once a reliable water supply becomes available.

5.04 In the absence of the project, there would be no significant change in cropping patterns in Pattani. With the project, some 15,000 ha of currently rainfed paddy land would be provided with irrigation and the

cropping intensity would increase from the present 100% to about 170%. A reliable water supply and improved water control would enable farmers to shift from local varieties to high-yielding varieties (HYVs). In the wet season about 50% of the project area would be planted to HYVs. Since some flooding would still occur, RD13, a long-strawed, photosensitive HYV, would be grown. This variety flowers in January after the risk of inundation has passed. In the dry season, semidwarf HYVs (RD7, RD9) would be grown exclusively. The expected changes in cropping patterns and production are shown in Table 5.1.

Yields and Production

5.05 Present and projected yields are shown in Table 5.2. With good water control, improved extension services and adequate supplies of credit and inputs, projected yields would be reached in the sixth year after completion of project works. Yield increases would be obtained from the provision of irrigation and drainage, increased planting of HYVs, better quality seed, heavier fertilizer inputs, and improved weed and pest control. In the case of Pattani, projections are based on yields presently obtained at local research stations, adjusted to field conditions. For Meklong, yields are based on results from the Chao Phya Irrigation Improvement Project (Cr. 379-TH) where soils and climate are similar to those in the project area. Projected yields at full development are lower for Pattani than for the Meklong area, reflecting the generally less favorable rice soils and the lack of experience in irrigated rice culture in the area. As a result of the project, paddy production in Meklong would increase from about 163,000 tons at present to 467,000 tons at full development and in Pattani from 22,000 tons to 78,000 tons. Sugarcane production would rise from 330,000 tons to 450,000 tons, despite the expected decrease in area cultivated.

Table 5.1: CROPPING PATTERNS AND PRODUCTION

	<u>Cropped Area</u>		<u>Production</u>	
	<u>Present</u>	<u>Future /a</u>	<u>Present</u>	<u>Future</u>
	<u>----- ('000 ha) -----</u>	<u>-----</u>	<u>--- ('000 ton) ---</u>	<u>-----</u>
<u>Meklong</u>				
<u>Wet Season</u>				
Rice - Local	60.0	15.2	140.1	53.2
- HYV	-	45.8	-	183.2
Subtotal	<u>60.0</u>	<u>61.0</u>	<u>140.1</u>	<u>236.4</u>
<u>Dry Season</u>				
Rice - HYV	8.5 /b	55.0	23.0	231.0
Total paddy	<u>68.5</u>	<u>116.0</u>	<u>163.1</u>	<u>467.4</u>
Sugar	6.00	5.0	330.0	450.0
Cropping intensity (%) /c	105	190	-	-
<u>Pattani</u>				
<u>Wet Season</u>				
Rice - Local	16.0	7.5	22.4	18.8
- HYV	-	7.5	-	22.5
Subtotal	<u>16.0</u>	<u>15.0</u>	<u>22.4</u>	<u>41.3</u>
<u>Dry Season</u>				
Rice - HYV	-	10.5	-	36.8
Total paddy	<u>16.0</u>	<u>25.5</u>	<u>22.4</u>	<u>78.1</u>
Sugar	-	-	-	-
Cropping intensity (%) /c	100	170	-	-

/a Meklong at full development 1990.

/b Includes 5,000 ha (flood area) cropped only in the dry season.

/c Applies to paddy area only.

Table 5.2: PRESENT AND PROJECTED YIELDS

	<u>Present</u>		<u>Future Without Project</u>		<u>Future With Project</u>	
	<u>Meklong</u>	<u>Pattani</u>	<u>Meklong</u>	<u>Pattani</u>	<u>Meklong</u>	<u>Pattani</u>
	----- (ton/ha) -----					
<u>Wet Season</u>						
Rice						
Native rainfed	2.2	1.4	2.5	1.6	-	-
Native irrigated	2.5	-	2.8	-	3.5	2.5
HYV	-	-	3.2	-	4.0	3.0
<u>Dry Season</u>						
Rice - HYV	3.0	-	3.3	-	4.2	3.5
Sugar, irrigated	55.0	-	75.0	-	90.0	-

Cropping Calendar

5.06 Figs. 5.1 and 5.2 show proposed crop calendars for Meklong and Pattani project areas. The main changes from existing practices are the introduction of dry-season cropping in Pattani and the expansion of dry-season cropping in Meklong. Some acceleration of operations would be necessitated in both project areas by higher cropping intensities and the need to have harvesting and threshing take place in the dryest condition available. With reliable irrigation, sequential planting and harvesting of sugarcane would take place during the dry season in the period December through April. The proposed calendar allows for system maintenance in Pattani during two periods of about three weeks duration in February/March and July/August. In Meklong, system maintenance would be undertaken in May/June and November/December.

Farm Mechanization

5.07 At present about 70% of the cropped area in the Meklong and 85% in Pattani depend on animal-drawn equipment for land preparation. With improved water management, better access to fields, and the need for tighter operating schedules to maximize water use and increase cropping intensities, it is estimated that mechanized land preparation for both wet- and dry-season crops would increase to about 90% in Meklong and 60% in Pattani. The machinery, both two- and four-wheel tractors, and rotary tillers, would be largely owned by farmers and contracted out to their neighbors, as is currently the practice. Contract plowing with 40-60 hp tractors is already well established in the Meklong sugarcane areas. At present, paddy is harvested in Pattani with a hand knife and in Meklong with a sickle. With increasing labor peaks at harvest under the project, it is anticipated that the sickle would replace the hand knife over about 50% of the Pattani project area. Threshing is done either manually or by mechanical threshers in Meklong and almost entirely by hand in Pattani. Under project conditions of better field access and better drainage, a moderate shift to mechanized threshing accounting for about 75% of future production is assumed in Meklong and 35% in Pattani.

Drying, Storage and Processing

5.08 At present threshed paddy is sun-dried on whatever suitable surfaces are available. Some of the rice mills have concrete drying floors. Sun-drying of paddy will continue under the project but additional drying floor space would be needed to accommodate increased yields. Similarly, storage capacity, which is ample for the present level of production would need to be expanded in the future. Storage facilities at some of the larger rice mills are currently underutilized, and farmers can increase their own storage capacity without difficulty. In addition, cooperative warehouses now being built as part of a countrywide government-sponsored program could be expected to meet part of the increased storage requirements. There are about 680 privately owned rice mills in the project areas. Assuming a 200-day milling season, these mills have an annual capacity of about 560,000 tons of paddy, compared to the present project area annual production of about 190,000 tons. However, since these mills also cater to the needs of farmers outside the project area, some additional milling capacity would be required at full development. The private sector can be expected to meet any additional milling requirements without difficulty.

6. MARKETS, PRICES, INCOMES AND PROJECT CHARGES

Market Prospects

6.01 Over the past 15 years domestic consumption of rice in Thailand increased at about 3% p.a. while production increased at around 2% p.a. Rice exports over the same period have averaged about 1.5 million tons annually, fluctuating between 0.85 million tons in 1973 and 2.9 million tons in 1972. The incremental project paddy production of 300,000 tons at full development constitutes about 1.5% of projected national production in 1990 and should not have a significant effect on either the domestic or export supply-demand situation.

6.02 At Meklong, production is presently sufficient to meet consumption needs of the rural population in the project areas and to satisfy part of the demand of adjacent urban areas. The projected marketable surplus can be disposed of in the nearby urban areas, in the adjoining sugar production areas where most farmers grow little or no rice, and in the Bangkok domestic and export market which is easily reached at low transport cost over a well-developed road, rail and waterway network.

6.03 At Pattani current production is barely adequate to meet the consumption demand of the rural population in the immediate vicinity of the project. Pattani province and the adjoining provinces of Yala and Narathiwat have a rice deficit of some 140,000 tons of paddy p.a., and without the project the deficit would widen to about 170,000 tons by 1990. Production in the three provinces has been increasing at about 1% p.a. whereas demand resulting from population growth alone has been increasing at about 2.5% p.a. over the past decade.

6.04 Incremental production from Pattani of about 53,000 tons of rice, p.a. would be easily disposed of in the three-province deficit area. Future surpluses of good-quality rice could be exported to Malaysia which currently imports about 200,000 tons of Thai rice annually. Pattani rice could develop a comparative advantage over Bangkok rice with respect to the Malaysia export market.

6.05 At present sugar production in Thailand is slightly in excess of total domestic and export demand, given the current export quota under the International Sugar Agreement. Present government policy is to reduce sugar production by promoting crop substitution in the marginal cane-growing areas. However, most of the project land planted to sugar is agronomically well-suited to the crop, is located close to a major sugar milling complex, and is likely to remain in sugar. Cane producers will have no difficulty in disposing of the future incremental production, which would constitute less than 1% of projected national production.

Prices

6.06 The price structure for rice and paddy used in the economic and financial analyses is presented in Table 6.1. The present and future prices are based on the Bank's commodity price forecasts, adjusted for grade differences, and expressed in January 1980 constant prices. The present and future average f.o.b. export prices are US\$320/ton and US\$480/ton, corresponding to financial farm-gate prices of B 2,400/ton and B 3,500/ton, respectively.

6.07 Export prices are largely determined by international market forces, although the composition of exports by grade depends on weather conditions at harvest time. Government intervention in the form of the rice export premium and other taxes, partially intended to stabilize domestic consumer prices, has resulted in depressed farm-gate prices. In recent years the Government has used part of the export premium proceeds to support farm-gate paddy prices by open market purchase and storage. For the 1978 wet season and the 1979 dry-season crops, funds were available to purchase about 15-20% of the marketed surplus paddy. Government policy also requires exporters to retain and store a specified quantity and grade of rice for each ton exported. The January 1979 reserve requirement was 0.5 ton of 15% brokens for each ton of any quality exported. This rice, which must be made available to the Government on demand at a fixed price, is used for Government-to-Government sales or released through special outlets in urban areas to control retail prices.

**Table 6.1: PRICE STRUCTURE OF RICE/PADDY
(B/ton)**

	1980		1990	
	Financial	Economic	Financial	Economic
Export price Thai 5% broken, f.o.b. Bangkok (US\$/ton) <u>/a</u> (Baht/ton)	320 6,400	320 6,400	480 9,600	480 9,600
Grade differential <u>/b</u>	6,190	6,190	9,300	9,300
Rice premium <u>/c</u>	835	-	835	-
Export duty <u>/d</u>	270	-	440	-
Municipal tax	10	-	15	-
Reserve requirement loss	465	-	1,290	-
Exporter's margin <u>/e</u>	425	295	610	420
Wholesaler's margin <u>/f</u>	205	140	290	200
Ex-mill price of rice	3,980	5,755	5,820	8,680
Ex-mill price of paddy	2,905	4,200	4,240	6,335
Tax <u>/g</u>	75	-	105	-
Miller's margin <u>/h</u>	210	150	310	225
Input price of paddy at mill:				
Bangkok	2,620	4,050	3,825	6,100
Merchant's margin <u>/i</u>	220	150	325	210
Farm-gate price of paddy	2,400	3,900	3,500	5,900

/a Based on current price structure and the Bank's commodity price projections, i.e., January 1979 price inflated by 6% for 1980, and the Bank's 1990 projection expressed in 1980 constant terms.

/b Weighted average f.o.b. price assuming 67% is 5% broken, 20% is Grade A (10, 15 and 20% broken) and 13% is Grade C (25, 35 and 45% broken). In January 1979, equivalent to 96.6% of the price for 5% broken. Same relationship in future.

/c Weighted average as in /b. Current rate is B 900/ton on 5% broken and B 700/ton on Grades A and C. Assumed to remain constant.

/d 5% of the "assessed price," which is about 87% of the export price. Same relationship in future.

/e Assuming 75% of the margin covers transport and handling costs and 25% goes to the exporter as profit, a weighted average conversion factor of 0.69 was used to convert from financial to economic price.

/f Conversion factor of 0.69 used to convert from financial to economic price.

/g Effective tax rate of 2.5%, present and future.

/h 7.5% of paddy output before tax. Conversion factor for milling is 0.72 to convert from financial to economic prices.

/i Includes transport, handling and profit. Assumed to be 8.5% of input price of paddy at the mill. Conversion factor of 0.69 has been used as in footnote /e.

Table 6.2: FARM-GATE PRICES OF INPUTS AND OUTPUTS
(B/ton) /a

	1980		1990	
	Financial	Economic	Financial	Economic
<u>Crops</u>				
Paddy	2,400	3,900	3,500	5,900
Sugar	280	275	415	495
<u>Fertilizers</u>				
Urea	5,100	4,400 (M) 4,500 (P)	6,500	5,500 (M) 5,650 (P)
KCl	3,600	3,300	4,600	4,200
TSP	6,100	5,200	8,550	7,250
Am. Sulfate	3,100	2,850	3,900	3,600
Ammophos	4,100	3,800 (M) 3,900 (P)	5,450	5,000 (M) 5,100 (P)

/a Prices expressed in 1980 constant values. (M) indicates Meklong and (P) Pattani.

6.08 The present and future economic prices were derived by taking the weighted average f.o.b. prices and working back to the farm-gate, excluding taxes and the rice premium and adjusting domestic costs by applying specific conversion factors to state all local costs in border price equivalents (Annex 4, Table 1). The resulting economic farm-gate prices are B 3,900/ton and B 5,900/ton for present and future respectively (in 1980 constant prices).

Farm Incomes

6.09 Farm budgets have been prepared for six farm models, representing typical farms of different sizes and cropping systems in the two project areas. The models for Meklong are for 2.0 ha and 4.0 ha rice farms; a 5.0 ha sugarcane farm has been included even though only about 7% of the area would be cropped under sugarcane with the project (para 5.03). For Pattani the budgets are for 1.0 ha and 2.5 ha rice farms and a 4.0 ha rice/rubber farm. In the farm models it is assumed that family labor contributes 60 man-days/month in Meklong and 72 man-days/month at Pattani. Hired labor is assumed only when demand exceeds the estimated family labor supply in a given month. Hired labor is costed at B 25/man-day at Meklong and B 20/man-day at Pattani. Project charges at the levels shown in para. 6.16 have been assumed in the farm budget analysis. The summary of the farm budget analysis presented in Table 6.3 shows that the project would increase farm incomes by two- to four-fold in both project areas.

Table 6.3: SUMMARY OF FARM BUDGETS /a

Farm model	Size of family (No.)	Farm Income				Per Capita Income	
		Present	Future	Present	Future	Present	Future
		----- (B) -----	-----	----- (US\$) -----	-----	----- (US\$) -----	-----
<u>Meklong</u>							
2.0 ha	6	15,655	41,350	785	2,070	130	345
4.0 ha	6	21,505	73,865	1,075	3,695	180	615
5.0 ha	6	40,200	113,830	2,010	5,690	335	950
<u>Pattani</u>							
1.0 ha	8	6,855	17,080	340	855	40	105
2.5 ha	8	10,595	36,185	530	1,810	65	225
4.0 ha	8	12,300	50,365	615	2,520	75	315
<u>Indicators</u>				<u>1980</u>	<u>1990 (in 1980 constant terms)</u>		
				(US\$)	(US\$)		
	Absolute poverty level (per capita)			150	150		
	Relative poverty level (per capita)			125	215		

/a From Annex 3, Tables 6 and 7. US\$ equivalents rounded to nearest \$5.

6.10 In the total project area, about 45% of the farm families are presently living on incomes at or beneath the absolute poverty level; at full development this figure would decrease to about 15%. In Meklong, the present per capita farm incomes range from US\$130 for a 2.0 ha rice farm to US\$335 for a 5.0 ha sugar farm. The incomes for the small farms are below the estimated per capita absolute poverty level of US\$150 (1980 prices) and are less than 25% of the estimated 1980 per capita GNP of US\$540 for Thailand. Analysis of farm budgets and farm size distribution data indicates that farm families with holdings smaller than 2.3 ha (about 24% of the Meklong project families) generally have incomes beneath the poverty level, even when their livestock, labor and other off-farm earnings are included. With the project, the per capita incomes in Meklong would range from US\$345 to US\$950, substantially above the poverty level and representing 37-103% of the 1990 projected per capita GNP (1980 prices) of US\$925. In Pattani, about 95% of the project farmers have incomes beneath the poverty level. The present per capita farm incomes range from US\$40 for a 1.0 ha rice farm to US\$75 for a 4.0 ha rice/rubber holding. These farm incomes are 25-50% of the 1980 absolute poverty level and represent 8-14% of the estimated 1980 per capita GNP. With the project, farm incomes are expected to increase to US\$105 to US\$315 per capita. Thus, about half of the Pattani farm families would still have incomes below the estimated absolute poverty level at full project development.

Project Charges

6.11 Until the early 1970s, the Bank had accepted the rice premium as an indirect form of cost recovery since it had brought the Government annual revenues ranging from US\$13 million to US\$165 million. By 1973, there was a general consensus in the Government that more direct cost recovery measures should be applied for intensive forms of agricultural development undertaken at public expense. The last five irrigation projects financed by Bank loans and credits have placed more emphasis on tertiary, or on-farm development than in the past and lead to clearly identifiable improvements in the productivity of individual holdings. For each of these projects the Government has undertaken to carry out studies to determine the appropriate level of charges to recover the cost of operating and maintaining the system and a reasonable portion of the investment cost.

6.12 On the basis of cost recovery studies carried out for the Chao Phya I project (Cr. 379-TH), the Government calculated that an annual fee of B 690/ha would recover without interest, 90% of the cost of tertiary facilities and 100% of the cost of land leveling, to be collected over 11 years. Recognizing the inadvisability of imposing a different charge on farmers in the Chao Phya II area, parts of which are immediately adjacent to the Chao Phya I, the Government decided to keep the same annual fee for both projects. They estimated that this fee, collected over 13 years, in Chao Phya II would recover, with 12% interest, 13% of the cost of tertiary facilities and the full cost of land leveling, or about 50% of the total capital costs of tertiary development. BAAC has agreed to serve as the collection agent for a fee of 2% of the funds collected and can commence activities as soon as cadastral surveys are completed establishing the exact size of each farmer's holding. In addition, an annual O&M fee of B 55/rai (US\$17.00/ha) would be collected from the project beneficiaries.

6.13 The existing legislation which empowers the Government to collect fees for irrigation is contained in the Land Consolidation Act and the Irrigation Act. The Land Consolidation Act allows collection of up to 90% of the cost of common irrigation works, the full cost of land leveling, and a fee for O&M in officially designated land consolidation areas, where holdings are fragmented and construction of project works involves boundary realignment and land leveling. Neither component of the proposed project is being developed in this manner. The Irrigation Act empowers the Government to collect a fee for operation and maintenance of the system, but has never been enforced because of the irregularity and unreliability of most of the irrigation systems constructed in the past.

6.14 The Government is undertaking to strengthen its legislative authority in regard to irrigation charges, particularly cost recovery, since the Land Consolidation Act is only applicable to a small portion of irrigated land in the central plain. They proposed under the Northeast Irrigation Project II (Ln. 1630-TH) to submit legislation to the National Assembly by June 1980 that would allow recovery of investment costs from beneficiaries of all irrigation projects.

6.15 For the proposed project, RID would, under the authority granted by the Irrigation Act, impose an O&M fee and begin collections after the first year of operation of the system. RID would determine appropriate levels of cost recovery after the system has been in operation two to three years and farmers have begun to realize project benefits. A cost recovery study would be made on the basis of farm data collected for monitoring and evaluation purposes and would take into account incentives to farmers, capacity of farmers to pay, size of farm holdings and other taxes and charges paid by farmers.

6.16 Assurances were obtained that the Government would:

- (a) prepare and submit to the Bank for review and comment by June 30, 1981, proposals for the amount of O&M fee to be levied on project beneficiaries and the mechanism by which such fees would be collected;
- (b) subject to (a) above, impose and collect an O&M fee, under terms and conditions satisfactory to the Bank, one year after the completion of the tertiary systems in blocks of 1,000 ha;
- (c) carry out a cost recovery study on the basis of data collected for monitoring and evaluation purposes, and prepare and submit to the Bank for review and comment, not later than December 31, 1984, proposals for charges to be levied on project beneficiaries; and
- (d) subject to (b) and (c) above, impose and collect charges, on terms and under procedures satisfactory to the Bank, not later than three years after completion of tertiary systems in blocks of about 3,000 ha, sufficient to recover a reasonable portion of the cost of the tertiary systems.

6.17 For the purpose of illustration, an analysis has been carried out assuming the same level of cost recovery now proposed for Chao Phya II (Table 6.4). Recovery of 50% of the cost of tertiary development, with 12% interest, would result in annual charges of B 980/ha in Meklong and B 465/ha in Pattani. In addition, farmers would pay O&M fees of B 300/ha for the main system and B 80/ ha for on-farm works. Based on the above charges, the rent recovery index in Meklong would range from 40 to 63%, with an average of 38%. The high index (63%) for a 5.0 ha sugar farm reflects the combination of a high present income, a low incremental income due to the project, and project charges applied to relatively large individual holdings. In Pattani, the rent recovery index would vary from 16 to 20%, averaging 17%. These indices show that there is ample scope for introducing water charges without impairing farmers' incentives to participate in the project. The cost recovery index would be 15% for Meklong and 7% for Pattani.

6.18 At present the Government imposes taxes on exported rice amounting to about B 1,600/ton (66% of the farm-gate price). For the average farm model tested, the indirect taxes imposed on incremental production would be four to five times as much as the cost recovery charges proposed above, indicating that the rice premium and other export taxes could be significant elements of decision in cost recovery policy. An analysis was carried out taking into account the rice premium, export duty and municipal tax and assuming that all incremental production due to the project would be available for export. Under these assumptions, the cost and rent recovery indices would be appreciably higher. In Meklong, the rent recovery index would vary between 67 and 78% and the cost recovery index increases from 15% (not including these taxes) to 73% (with taxes). In Pattani, the rent recovery index would range from 48 to 57% and the cost recovery index would increase from 7 to 36%. An important element in cost recovery policy is whether the Government would give more weight to increased farm incomes or to tax revenue for further development. Taking into account the relative income level of the beneficiaries (Table 6.3), the foregoing analysis indicates that the assumed charges would be satisfactory for the 2.0 ha Meklong farm, but that there may be scope for higher taxation on farms 4.0 ha and larger. In Pattani, however, imposing any capital cost recovery charges may be inappropriate on the basis of the beneficiaries' relative income position, in which case recovery of O & M costs would be sufficient, and the capital costs of irrigation could be considered a transfer payment to these farmers. Final determination of the level of charges in both areas would be made after the cost recovery study (para 6.15) is carried out.

Table 6.4: COST AND RENT RECOVERY /a

	Meklong				Pattani			Total project (B million)
	2.0 ha (Rice)	4.0 ha (Rice)	5.0 ha (Sugar)	Total project (B million)	1.0 ha (Rice)	2.5 ha (Rice)	4.0 ha (Rice/rubber)	
	Baht				Baht			
At Full Project Development								
Incremental gross value of farm production /b	36,085	72,170	31,125	879.1	12,600	31,500	37,800	183.3
Less: Incremental cash production costs /c	9,265	22,760	10,741	243.3	2,115	5,440	6,590	31.4
Loss of off-farm income /d	4,500	4,200	-	88.9	1,200	2,800	-	11.0
Equals: Incremental net cash income	22,320	45,210	20,385	546.9	9,285	23,260	31,210	140.9
Less: Incremental								
- imputed return on own capital/e	60	120	(355)	1.0	10	30	35	-
- imputed value of family labor /f	6,100	7,975	2,850	131.3	1,840	4,240	5,205	25.7
- imputed value of management service /g	3,610	10,825	4,670	102.1	1,260	3,150	3,780	18.3
- depreciation /h	1,805	3,610	3,110	45.5	630	1,575	1,890	9.2
- allowance for risk /i	5,415	7,215	1,555	116.1	1,890	4,725	5,670	27.5
Equals: Project rent	5,330	15,465	8,555	150.9	3,655	9,540	14,630	60.2
Project rent as % of incremental cash income	24	34	42	28	39	41	47	43
Project charges:								
Main system O&M /j	600	1,200	1,500	19.8	300	750	900	4.5
On-farm O&M /k	160	320	400	5.3	80	200	240	1.2
On-farm development /l	1,150	2,295	2,870	37.9	270	680	815	4.1
Total direct charges	1,910	3,815	4,770	63.0	650	1,630	1,955	9.8
Export taxes:								
Rice premium /m	5,760	11,525	-	140.3	2,010	5,035	6,010	29.4
Export duty /n	3,035	6,070	-	73.9	1,060	2,655	3,170	15.5
Municipal taxes /o	105	210	-	2.5	35	90	110	0.5
Total indirect charges	8,900	17,805	-	216.7	3,105	7,780	9,290	45.4
Discounted Over 30-Year Evaluation Period /p								
Project rent	34,200	99,100	54,800	697.2	23,400	61,200	93,800	273.9
Total direct charges	13,800	27,900	34,500	265.4	4,800	12,200	14,600	45.4
Rent recovery index	40	28	63	38	20	20	16	17
Total indirect charges	57,100	114,100	-	1,001.2	19,800	49,800	59,500	206.6
Rent recovery index including indirect charges	78	67	-	75	67	56	48	53
Project cost (capital and recurring)				1,736.5				690.9
Cost recovery index				15				7
Cost recovery index including indirect charges				73				36
Farm income per capita at full development (US\$)	345	615	950		105	225	315	

/a All calculations are in January 1980 financial prices and represent incremental conditions, i.e., with minus without the project at full development.

/b Annex 3, Tables 6 and 7.

/c Includes hired labor and interest on production credit.

/d Assumes that farmer must relinquish all or part of his off-farm income to meet labor demands of increased cropping intensity.

/e Assumes 8% p.a. return on portion of production costs met from farmers' own resources.

/f Incremental labor requirements less incremental hired labor valued at market wages (B 25/day for rice and B 30/day for sugar cane in Meklong and B 20/day in Pattani).

/g 10% of incremental gross value of production for project holdings up to 3.0 ha, 15% for larger holdings.

/h 5% of incremental gross value of production for rice farms, 10% for sugar farms.

/i 15% of incremental gross value of production for project holdings up to 3.0 ha, 10% for larger holdings.

/j B 300/ha.

/k B 80/ha.

/l Charge stated is for the first year of full development of the project (1990) in January 1980 prices. Since the assumed terms of repayment, in Baht, are not revalued for inflation, it has been brought to January 1980 prices assuming a long-term inflation rate of 6% per annum.

/m B 835/ton.

/n B 440/ton.

/o B 15/ton.

/p Present values expressed in January 1980 values discounted at 12% per annum over 30 years.

7. BENEFITS, JUSTIFICATION AND RISKS

7.01 The proposed project would increase cropping intensities and yields on about 81,000 ha through the improvement, rehabilitation and extension of irrigation works. Rice would be the major crop grown during the wet and dry seasons and there would be about 5,000 ha of irrigated sugarcane grown in the Meklong area. Approximately 30,400 farm families would benefit directly from the increased production and employment. The project would generate demand for an additional 5.2 million man-days of labor per year and would help to meet the Government's objectives of more balanced regional growth, increased incomes for the poorer segment of the rural population, and increased production of food and cash crops. The incremental annual production of 200,000 tons of milled rice at full development would result in net annual foreign exchange earnings of about US\$51 million (in 1980 constant terms). The average capital cost per directly benefited family in 1980 prices is US\$4,335 in Pattani and US\$4,735 in Meklong.

7.02 Distribution of benefits. Farmers within the two project areas will benefit from the projects roughly in proportion to the area of land they cultivate in a given year. The distribution of benefits can be expected to be more favorable than indicated by the size distribution of farm holdings (Table 2.2, page 12) because (a) farmers with relatively small farms are likely to rent land from farmers with large holdings, (b) cropping intensities are likely to be higher on small farms than large farms, and (c) there will be a trend towards subdivision of the larger holdings (particularly those above 5 ha) among adult family members or through sale to others, because of the demanding management requirements for intensive year-round activities. The effect of these factors cannot be readily predicted, but it is likely to be significant. For example, in Meklong 11,000 farmers with holdings below 3 ha (51% of the total) own just over 21,000 ha (30% of the gross area). If these farmers were to rent on average one additional ha, they would as a group come close to receiving 50% of the project benefits. In Pattani, there is a more uniform distribution of land holdings; farmers with holdings between 1 and 3 ha (60% of the total) own 60% of the land. However, farmers with less than 1 ha account for 25% of the total and own 8% of the land, in contrast to the larger farmers (over 4 ha) who own 22% of the land. Nevertheless, a significant shift in benefits towards the small farmers can be expected through rental, more intensive cropping, and subdivision of large holdings. The current rental rates in the areas developed in Bank-financed projects in the Chao Phya Plain is B 1,200-1,500/ha (\$60-75/ha), which would be about 20% of the incremental income/ha.

7.03 Foreign Exchange. The unit of account is uncommitted foreign exchange in the hands of the Government, expressed in terms of local currency. All tradeable components are valued directly in foreign exchange and converted to local currency at the official exchange rate and adjusted for local transport and handling. Specific conversion factors for a number of broad categories of goods and services produced or consumed by the project have been used to express all nontradeable inputs and outputs in terms of the common unit of account (Annex 4, Table 1).

7.04 Benefits. Expected future yields and production with and without the project and prices of inputs and outputs are discussed in Chapter 5. Production costs and returns, farm budgets and incomes, and labor requirements

are given in Annex 3. The expected benefits at full agricultural development for the two components and the project as a whole are given in Annex 4, Table 2.

7.05 Farm Labor. There are about 21,500 farm families in the Meklong project area, with an average family size of six. With 2.5 workers per agricultural family, the total farm labor force is about 53,750, and the labor supply, on the basis of 24 work days per month, is about 1.3 million man-days per month or 15.5 million man-days per year. Assuming a growth in the rural labor force of 1% per year, the labor supply at full development would be 1.5 million man-days per month or 17.9 million man-days per year.

7.06 The demand for labor in the Meklong area is strongly influenced by labor requirements of the major sugarcane-producing areas of Thailand located immediately adjacent to the project. The sugar milling season - from December through April - corresponds approximately to the period of minimum labor demand within the Meklong project at present, resulting in greater off-season employment of the project labor force than for many other rice-growing areas. With the project, labor demand peaks would occur in February, May, August and November. During these months 90-95% of the project labor force would be required. Further increases in mechanization of cultivation and harvest beyond the assumed rates are possible and would result in lower labor demands in peak periods. Information on prevailing wage rates for agricultural labor in the Meklong area during different periods of the year indicates an annual average market wage of about B 25/day. This wage is believed to reasonably reflect the opportunity cost of unskilled labor in the project vicinity.

7.07 In the Pattani project area, there are about 8,900 farm families with an average of eight persons. With three workers per family, the total labor force is about 26,700. The labor supply is estimated to increase from about 0.6 million man-days per month (7.7 million man-days per year) at present to about 0.7 million man-days per month (8.9 million man-days per year) at full development.

7.08 The demand for labor within the proposed service area in the Pattani project is at present largely limited to the wet season, which occurs roughly from August to March, but a significant off-season labor demand is generated by the rubber-growing areas near the project area. Nevertheless, there is considerable underemployment of the rural labor force due in part to the relatively low (for Thailand) land:man ratio and low productivity, resulting in a lower-than-average market wage of B 20/day. With the project, farm employment opportunities would increase from 1.5 million man-days per year at present to 2.7 million man-days at full project development. In months of peak labor demand for rice, the overall labor supply would be more than adequate although larger holdings would need some hired labor which could be provided by smaller farms. There would be no need to rely on labor from outside the project area. Estimates of total monthly labor requirements for both project areas are given in Annex 4, Table 3.

7.09 Project Costs. In the economic analysis, all financial costs have been expressed in 1980 constant values. Taxes and transfer payments have been excluded (cost of civil works reduced 10%) and local costs have been multiplied by the conversion factor for construction (0.74). The total investment cost of the Meklong component is US\$82.2 million, including civil works (US\$51.5 million), equipment (US\$10.2 million), engineering and administration (US\$6.6 million), consultants (US\$2.9 million), buildings (US\$0.6 million), land acquisition (US\$1.9 million) and physical contingencies (US\$8.5 million). For Pattani, the total investment cost is US\$29.5 million, comprising civil works (US\$17.0 million), equipment (US\$3.4 million), engineering and administration (US\$2.7 million), land acquisition (US\$1.9 million), consultants (US\$1.1 million), buildings (US\$0.6 million), and physical contingencies (US\$2.8 million). For both components, the estimated annual incremental cost of O&M is US\$15/ha for the main system and US\$4/ha for the on-farm works.

7.10 Economic costs of land acquired for right-of-way for main canals, laterals and drains were determined by calculating the economic opportunity cost of the land under several categories of land use and applying the unit costs to the area acquired. The economic cost of land lost to on-farm development works is accounted for by an area reduction from the "without project" to the "with project" case. The cost of flood control works not directly related to the project has been excluded.

7.11 Development Period. All works under the proposed project would be completed in Meklong in mid-1985 in time for the 1985 wet-season crop and in Pattani in mid-1984 in time for the 1984/85 wet-season crop. Beginning with the first crop grown under project conditions, farmers would achieve projected full production levels over six years. Both project components would achieve full development benefits with the 1990 dry-season crop.

7.12 Economic Rate of Return. Using the foregoing assumptions and discounting costs and benefits over a 30-year evaluation period, the economic rate of return for the proposed project is 32%. The economic rates of return for each component are 35% for Meklong and 23% for Pattani.

7.13 Sensitivity of the Economic Rate of Return. Sensitivity analysis has been carried out to determine which variables would be most crucial to the success of the project. As a measure, the crossover value was used, defined as the value of the variable tested for which the NPV discounted at 12% was zero. The crossover value may be interpreted as the value of the variable tested, beyond which the economic rate of return would be below 12%. The results are presented in Annex 4, Table 5 and discussed below.

- (a) Project yields. The project is not very sensitive with respect to yields. Even if yields were to be 1/3 lower than anticipated, the rate of return would still be 12%.

- (b) Dry-season cropping intensity. It is assumed that in the future, dry season cropping would increase to about 16,500 ha with the existing level of irrigation facilities in Meklong and to 55,000 ha at full development of the project. With the higher yields anticipated in both seasons due to the project, dry season cropping would have to be limited to less than 12,500 ha before the economic rate of return would fall below 12%. In Pattani, where lack of irrigation facilities precludes any dry season cropping in the future without the project, if a second crop were to be grown on 1,900 ha with the project, the economic rate of return would still be 12%.
- (c) Price of rice. The cross-over value represents in Meklong a 55% decrease in the forecast world market price of rice and a 45% decrease in Pattani, which seems unlikely.
- (d) Construction costs. The cost of construction would have to increase to almost four times the present estimate for Meklong and more than twice for Pattani before the economic rate of return for either of the projects would fall below 12%.
- (e) Development period. The development period would have to be extended to 23 years for Meklong and 21 years for Pattani before the ERR would fall below 12%.

7.14 Sunk Costs. Since the proposed project represents the incremental investment necessary to complete irrigation programs in which RID has been involved since the mid- to late-1960s, each component has also been analyzed to determine whether the original investment decision is still valid. Past costs have been expressed in 1980 constant values and converted to economic values by a conversion factor of 0.80. In Pattani, 40% of the expenditures between 1968 and 1979 have been apportioned to the 15,000 ha served by the right main canal. In Meklong, past expenditures have been for the main canals and 18% of the cost of the existing headworks structures, apportioned to the right bank system as its share of the potential area to be served by these facilities. Investment costs have been incurred since 1964 with only minimal incremental benefits, which have been ignored in the analyses. With the above assumptions, the economic rate of return is 15% in Meklong and 13% in Pattani.

7.15 Stage I Pattani. In addition to the sunk cost analysis of the right main canal system, the entire Stage I development of Pattani has been studied. Future costs for the development of 33,000 ha in the Stage I area, not included in the proposed project, have been derived from the feasibility study update (1977) carried out by SPI and adjusted to reflect price increases and works completed since 1977. Construction of the remainder of Stage I is expected to begin in 1982 and be completed in 1985. Incremental benefits at full development in 1991 have been calculated on the same basis

as in the 15,000 ha right main canal area of the proposed project. With these assumptions, and including RID's past expenditures between 1968 and 1969, the economic rate of return is 14%.

7.16 Risks. There are no unusual risks associated with the project. The risks normally associated with irrigation projects have been accounted for in estimating yields, cropping intensities, and rates of development. In comparing the two components, lower yields are assumed for Pattani where farmers have had less exposure to irrigated agriculture and the use of modern inputs.

8. AGREEMENTS REACHED AND RECOMMENDATION

8.01 During negotiations agreement with the Government was reached on the following principal points:

- (a) RID would employ consultants to assist in project implementation, operation and management, and monitoring and evaluation for each component, and in preparation of designs for completion of Pattani Stage I (para. 4.04);
- (b) BAAC would make available the additional staff and funds needed to meet the credit requirements of farmers in both project areas (para. 4.09);
- (c) RID would not later than December 31, 1980, submit to the Bank for review and comment their detailed proposals for monitoring and evaluation of Bank-financed irrigation projects (para. 4.12);
- (d)
 - (i) RID would prepare and submit to the Bank for review and comment by June 30, 1981, proposals for the amount of O&M fee to be levied on project beneficiaries and the mechanism by which such fees would be collected (para. 6.16);
 - (ii) subject to (i) above, RID would impose and collect an O&M fee, under terms and conditions satisfactory to the Bank, one year after operation of tertiary systems in blocks of 1,000 ha (para. 6.16);
 - (iii) RID would carry out a cost recovery study on the basis of data collected for monitoring and evaluation purposes, and prepare and submit to the Bank for review and comment not later than December 31, 1984, proposals for charges to be levied on project beneficiaries (para. 6.16); and
 - (iv) subject to (ii) and (iii) above, impose and collect charges, on terms and conditions satisfactory to the Bank, not later than three years after completion of tertiary systems in blocks of about 3,000 ha, sufficient to recover a reasonable portion of the cost of the tertiary system (para. 6.16).

8.02 With the above assurances, the proposed project would be suitable for a Bank loan of US\$80.0 million, with a 20-year maturity including a grace period of five years. The Borrower would be the Kingdom of Thailand.

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Cost Estimate Summary - Meklong

Item	Local	Foreign	Total	Local	Foreign	Total	%
	---- (B million)	(B million)	-----	--- (US\$ million)	---	---	foreign exchange
<u>Rehabilitation</u>							
1R canal - 65 km	49.3	32.9	82.2	2.5	1.6	4.1	40
2R canal - 67 km	17.7	11.8	29.5	0.9	0.6	1.5	40
Laterals - 207 km	64.3	52.6	116.9	3.2	2.6	5.8	45
<u>Construction</u>							
1R canal - 33 km	71.0	65.5	136.5	3.5	3.3	6.8	48
Laterals - 103 km	90.4	83.5	173.9	4.5	4.2	8.7	48
Drains - 336 km	115.9	77.2	193.1	5.8	3.9	9.7	40
On-farm devel. - 71,000 ha	399.6	327.6	727.2	20.0	16.4	36.4	45
Less depreciation force acct. equip.	(3.6)	(67.8)	(71.4)	(0.2)	(3.4)	(3.6)	95
Subtotal - civil works	<u>804.6</u>	<u>583.3</u>	<u>1,387.9</u>	<u>40.2</u>	<u>29.2</u>	<u>69.4</u>	42
<u>Equipment</u>							
Construction	9.8	178.0	187.8	0.5	8.9	9.4	95
Operation and maintenance	1.5	28.5	30.0	0.1	1.4	1.5	95
Communication	0.3	1.0	1.3	-	0.1	0.1	77
Subtotal - equipment	<u>11.6</u>	<u>207.5</u>	<u>219.1</u>	<u>0.6</u>	<u>10.4</u>	<u>11.0</u>	95
Buildings	12.0	3.0	15.0	0.6	0.1	0.7	20
Land acquisition	97.0	-	97.0	4.9	-	4.9	-
Consulting services & training	22.9	42.1	65.0	1.1	2.2	3.3	65
Engineering & administration	143.4	25.3	168.7	7.1	1.3	8.4	15
Base costs	<u>1,091.5</u>	<u>861.2</u>	<u>1,952.7</u>	<u>54.5</u>	<u>43.2</u>	<u>97.7</u>	44
Physical contingencies	114.5	93.7	208.2	5.7	4.7	10.4	45
Price increases	318.5	260.6	579.1	15.8	13.1	28.9	45
<u>Total Cost</u>	<u>1,524.5</u>	<u>1,215.5</u>	<u>2,740.0</u>	<u>76.0</u>	<u>61.0</u>	<u>137.0</u>	44

THAILANDIRRIGATION XICost Estimate Summary - Pattani

Item	B million			US\$ million			% foreign exchange
	Local	Foreign	Total	Local	Foreign	Total	
<u>Right Main Canal Facility</u>							
Canal rehabilitation - 0-24.5 km	22.6	15.0	37.6	1.1	0.8	1.9	40
Canal construction - 24.5-50.3 km	48.8	45.0	93.8	2.5	2.2	4.7	48
Lateral system	57.3	52.8	110.1	2.9	2.6	5.5	48
Drainage system	85.4	57.0	142.4	4.3	2.8	7.1	40
On-farm development	47.2	38.6	85.8	2.4	1.9	4.3	45
Less depreciation force acct. equip.	(1.2)	(22.8)	(24.0)	(0.1)	(1.1)	(1.2)	95
Subtotal - civil works	<u>260.1</u>	<u>185.6</u>	<u>445.7</u>	<u>13.1</u>	<u>9.2</u>	<u>22.3</u>	<u>42</u>
<u>Equipment</u>							
Construction	2.9	55.1	58.0	0.1	2.8	2.9	95
Operation and maintenance	0.5	9.5	10.0	-	0.5	0.5	95
Communication	0.2	0.6	0.8	-	0.1	0.1	75
Subtotal - equipment	<u>3.6</u>	<u>65.2</u>	<u>68.8</u>	<u>0.1</u>	<u>3.4</u>	<u>3.5</u>	<u>95</u>
Buildings	12.0	3.0	15.0	0.7	0.1	0.8	20
Land acquisition	98.9	-	98.9	4.9	-	4.9	-
Consulting services	23.8	23.8	47.6	1.2	1.2	2.4	50
Engineering and administration	60.5	10.1	70.6	3.0	0.5	3.5	15
<u>Base Costs</u>	<u>458.9</u>	<u>287.7</u>	<u>746.6</u>	<u>23.0</u>	<u>14.4</u>	<u>37.4</u>	<u>30</u>
Physical contingencies	38.8	28.1	66.9	1.9	1.4	3.3	42
Price increases	101.3	64.7	166.0	5.1	3.2	8.3	39
<u>Total Cost</u>	<u>599.0</u>	<u>380.5</u>	<u>979.5</u>	<u>30.0</u>	<u>19.0</u>	<u>49.0</u>	<u>39</u>

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IRRIGATION XI

Schedule of Expenditures - Meklong
(B million)

Item	1980	1981	1982	1983	1984	1985	Total
<u>Rehabilitation</u>							
1R canal	5.0	55.0	22.2	-	-	-	82.2
2R canal	-	15.0	14.5	-	-	-	29.5
Laterals	2.4	35.0	35.0	35.0	9.5	-	116.9
<u>Construction</u>							
1R canal	65.0	65.0	6.5	-	-	-	136.5
Laterals	60.0	60.0	53.9	-	-	-	173.9
Drains	-	38.1	58.0	50.0	47.0	-	193.1
On-farm development	-	40.0	100.0	200.0	200.0	187.2	727.2
Less depreciation force acct. equip.	-	(6.4)	(10.0)	(20.0)	(20.0)	(15.0)	(71.4)
Subtotal - civil works	<u>132.4</u>	<u>301.7</u>	<u>280.1</u>	<u>265.0</u>	<u>236.5</u>	<u>172.2</u>	<u>1,387.9</u>
Equipment	50.0	137.2	31.9	-	-	-	219.1
Buildings	-	5.0	10.0	-	-	-	15.0
Land acquisition	42.0	25.0	15.0	15.0	-	-	97.0
Consulting services & trg.	15.0	10.0	10.0	10.0	10.0	10.0	65.0
Engineering & administration	19.8	45.6	33.2	27.5	24.6	18.0	168.7
Subtotal - equipment & services	<u>126.8</u>	<u>222.8</u>	<u>100.1</u>	<u>52.5</u>	<u>34.6</u>	<u>28.0</u>	<u>564.8</u>
Physical contingencies	19.9	45.2	42.0	39.8	35.5	25.8	208.2
Price increases	12.0	77.6	103.5	127.1	140.6	118.3	579.1
<u>Total Cost</u> (US\$ million)	<u>291.1</u> (14.6)	<u>647.3</u> (32.4)	<u>525.7</u> (26.3)	<u>484.4</u> (24.2)	<u>447.2</u> (22.4)	<u>344.3</u> (17.1)	<u>2,740.0</u> (137.0)

THAILANDIRRIGATION XISchedule of Expenditures - Pattani
(B million)

	1980	1981	1982	1983	1984	Total
<u>Right Main Canal Facility</u>						
Canal rehabilitation - 0-24.5 km	18.9	17.0	1.7	-	-	37.6
Canal construction - 24.5-50.3 km	-	39.5	54.3	-	-	93.8
Lateral system	-	49.5	60.6	-	-	110.1
Drainage system	19.7	24.2	27.7	32.7	38.1	142.4
On-farm development	-	4.2	27.2	27.2	27.2	85.8
Less depreciation force acct. equip.	-	(2.0)	(6.0)	(8.0)	(8.0)	(24.0)
Subtotal - civil works	<u>38.6</u>	<u>132.4</u>	<u>165.5</u>	<u>51.9</u>	<u>57.3</u>	<u>445.7</u>
Equipment	30.0	38.8	-	-	-	68.8
Buildings	2.0	13.0	-	-	-	15.0
Land acquisition	29.5	41.5	27.9	-	-	98.9
Consulting services	5.0	14.0	13.6	10.0	5.0	47.6
Engineering and administration	14.5	20.1	20.8	9.2	6.0	70.6
Subtotal - equipment & services	<u>81.0</u>	<u>127.4</u>	<u>62.3</u>	<u>19.2</u>	<u>11.0</u>	<u>300.9</u>
Physical contingencies	5.8	19.9	24.8	7.8	8.6	66.9
Price increases	5.0	37.2	61.7	27.2	34.9	166.0
<u>Total Cost</u> (US\$ million)	<u>130.4</u> (6.5)	<u>316.9</u> (15.9)	<u>314.3</u> (15.7)	<u>106.1</u> (5.3)	<u>111.8</u> (5.6)	<u>979.5</u> (49.0)

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Expected Price Increases
(B million)

Item	1980	1981	1982	1983	1984	1985	Total
<u>Annual inflation rates (%)</u>							
Civil works	10	10	9	8	7	7	
Equipment and services	7	7	7	6	6	6	
<u>Compounded inflation rates (%)</u>							
Civil works	5.0	15.5	26.4	37.2	47.4	57.7	
Equipment and services	3.5	10.7	18.5	26.2	33.7	41.8	
<u>Meklong</u>							
Civil works	152.3	347.0	322.1	304.7	272.0	198.0	1,596.1
Equipment and services	126.8	222.8	100.1	52.5	34.6	28.0	564.8
<u>Total - w/physical conting.</u>	<u>279.1</u>	<u>569.8</u>	<u>422.2</u>	<u>357.2</u>	<u>306.6</u>	<u>226.0</u>	<u>2,160.9</u>
<u>Expected price increases</u>							
Civil works	7.6	53.8	85.0	113.3	128.9	106.6	459.2
Equipment and services	4.4	23.8	18.5	13.8	11.7	11.7	83.9
<u>Total Price Increase</u> (US\$ million)	<u>12.0</u> (0.6)	<u>77.6</u> (3.9)	<u>103.5</u> (5.2)	<u>127.1</u> (6.4)	<u>140.6</u> (7.0)	<u>118.3</u> (5.8)	<u>579.1</u> (28.9)
<u>Pattani</u>							
Civil works	44.4	152.3	190.3	59.7	65.9	-	512.6
Equipment and services	81.0	127.4	62.3	19.2	11.0	-	300.9
<u>Total - w/physical conting.</u>	<u>125.4</u>	<u>279.7</u>	<u>252.6</u>	<u>78.9</u>	<u>76.9</u>	-	<u>813.5</u>
<u>Expected price increases</u>							
Civil works	2.2	23.6	50.2	22.2	31.2	-	129.4
Equipment and services	2.8	13.6	11.5	5.0	3.7	-	36.6
<u>Total Price Increase</u> (US\$ million)	<u>5.0</u> (0.2)	<u>37.2</u> (1.9)	<u>61.7</u> (3.1)	<u>27.2</u> (1.4)	<u>34.9</u> (1.7)	-	<u>166.0</u> (8.3)

THAILAND

IRRIGATION XI

Meklong

Construction Equipment

Item	Number	Unit cost	Total cost
		----- (US\$'000) -----	-----
Bulldozer, track, 180 hp, w/push block & ripper	2	85	170
Bulldozer, track, 300 hp, w/push block & ripper	2	100	200
Bulldozer, track, 180 hp, straight blade	5	85	425
Bulldozer, track, 180 hp, angle blade, w/ripper	2	75	150
Bulldozer, rubber wheel, 170 hp	3	65	195
Bulldozer, track, 140 hp, straight blade	7	50	350
Bulldozer, track, 140 hp, LGP, straight blade	4	70	280
Motor scrapers, 11 cu yd, self-loading	15	70	1,050
Motor graders, 125 hp	5	55	275
Roller tamper, self-propelled	2	75	150
Road roller, 10 ton	2	25	50
Front end loader, 2-1/2 cu yd cap.	1	55	55
Front end loader, 1-1/2 cu yd cap.	4	35	140
Backhoe, 0.6 cu m, long reach, 6 mts.	6	80	480
Backhoe, 3/4 cu yd, track type	3	40	120
Backhoe, 3/4 cu yd, wheel type	4	40	160
Crane, crawler, w/dragline bucket, 1-1/2 cu yd	11	100	1,100
Crane, truck mounted, 25T cap.	1	120	120
Farm tractor, 80 hp	2	12	24
Land plane, hydraulic	2	10	20
Truck, dump, 5 cu yd cap.	6	22	132
Truck, dump, 4 cu yd	10	18	180
Truck, cargo, 25,000 lbs GVW	5	14	70
Truck, water tank, 6,000 lit. cap. w/pump	6	18	108
Truck, fuel tank, 6,000 lit. cap.	4	22	88
Truck, service, w/tools, welding & lub. eqpt.	3	40	120
Car, passenger, 2,000 cc	7	18	126
Station wagon, 4-wheel drive	15	11	165
Truck, pickup, 1 ton, 4-wheel drive	14	9	126
Truck, pickup, 1 ton, 2-wheel drive	45	5	225
Trucks, w/hyd. hoist attachment, 5 tons	2	22	44
Motorcycles, 100 cc	80	1	80
Tractor, truck, w/low bed trailer, 50 ton cap.	1	100	100
Microbus, passenger	1	12	12
Truck, conc. mixer, 4 cu yd cap.	4	40	160

Item	Number	Unit cost	Total cost
		----- (US\$'000) -----	-----
Batch plant, concrete, mobile, 30 cu m/hr cap.	1	75	75
Air compressor, 365 cfm, w/air receiver	2	18	36
Jackhammer, w/3 pavement breaker blades	10	2	20
Genset, 15 kw, trailer mtd.	6	5	30
Engine, caterpillar for rehab. of RID crane, 1-1/2 cu yd dragline	5	20	100
Track group, complete for rehab. of RID crane, 1-1/2 cu yd cap. dragline	5	22	110
Concrete and density testing equipment	1 lot	250	250
Survey equipment	1 lot	50	50
Office equipment	1 lot	200	200
Subtotal			<u>8,121</u>
Spare parts and misc. items			1,229
<u>Total</u>			<u>9,350</u>

THAILANDIRRIGATION XIPattaniConstruction Equipment

Item	Number	Unit cost Total cost	
		----- (US\$'000) -----	-----
Dragline, track, 1-1/2 cu yd	1	100	100
Dragline, rubber tire, 3/4 cu yd w/crane	1	120	120
Dragline, marsh type, 1/2 cu yd w/crane	1	150	150
Motorscraper, 11 cu yd, self-loading	4	70	280
Motor grader, 160 hp	1	55	55
Motor grader, 125 hp	1	55	55
Backhoe, track, 3/4 cu yd	3	40	120
Front-end loader, 1-1/2 cu yd	2	50	100
Bulldozer, track, 180 hp	2	85	170
Bulldozer, track, 140 hp	2	50	100
Bulldozer, rubber tire, 170 hp	1	65	65
Bulldozer, LGP track, 140 hp	2	74	148
Roller, self-propelled	1	22	22
Trucks, water tank, 6,000 lit.	3	18	54
Trucks, fuel tank, 6,000 lit.	2	22	44
Farm tractor, w/ditcher	1	12	12
Truck, field lub. service	1	20	20
Dump trucks, 4 cu yd	9	18	162
Station wagon, 4-wheel drive	5	11	55
Pickup trucks, 4-wheel drive	4	9	36
Pickup trucks, 1 ton, 2-wheel drive	15	5	75
Trucks, flatbed, 2-wheel drive	7	9	63
Tractor, truck, w/low bed trailer, 50-ton cap.	1	100	100
Station wagon, 2-wheel drive	5	8	40
Motorcycles, 100 cc	19	1	19
Concrete and dewatering equipment	1 lot	210	210
Workshop equipment	1 lot	74	74
Generators and electrical equipment	1 lot	37	37
Laboratory equipment	1 lot	25	25
Survey equipment	1 lot	52	52
Subtotal			<u>2,563</u>
Spare parts			287
<u>Total construction equipment</u>			<u>2,850</u>

THAILAND

IRRIGATION XI

Meklong

Operation and Maintenance Equipment

Item	Number	Unit cost ----- (US\$'000) -----	Total cost -----
Front end Loader, 1-1/2 cu yd, 100 hp	2	50	100
Bulldozer, track type, 140 hp	4	50	200
Bulldozer, track type, 120 hp	2	40	80
Crane, crawler, dragline, 3/4 cu yd	2	60	120
Motor grader, 125 hp	4	55	220
Farm tractor, 80 hp, w/mower attachment	5	20	100
Farm tractor, 80 hp, w/dozer blade & backhoe attachment	5	20	100
Truck, dump, 4 cu yd	7	18	126
Truck, cargo, 25,00 lbs GVW	6	14	84
Truck, service, w/tools, welding & lub. eqpt.	1	40	40
Water truck - 6,000 liter	5	18	90
Miscellaneous shop, concreting & survey eqpt.	1 lot	100	100
Subtotal			<u>1,360</u>
Spare parts			165
<u>Total O&M equipment</u>			<u>1,525</u>
Communication equipment	1 lot		65

THAILANDIRRIGATION XIPattaniOperation and Maintenance Equipment

Item	Number	Unit cost ----- (US\$'000) -----	Total cost
Bulldozer, track, 180 hp	1	85	85
Motor grader, 160 hp	1	55	55
Front end loader, 1-1/2 cu yd	1	50	50
Backhoe, track, 3/4 cu yd	1	40	40
Station wagon, 2-wheel drive	1	8	8
Pickup trucks, 1 ton, 2-wheel drive	2	5	10
Dump trucks, 4 cu yd	2	18	36
Motorcycles, 100 cc	10	1	10
Boat, runabout	1	13	13
Shop, survey, and miscellaneous equipment	1 lot	100	100
Office equipment	1 lot	50	50
Subtotal			<u>457</u>
Spare parts			53
<u>Total O&M equipment</u>			<u>510</u>
Communication equipment	1 lot		105

THAILAND
IRRIGATION XI

Estimated Schedule of Disbursements

<u>IBRD Fiscal Year</u> <u>and Semester</u>	<u>Accumulated</u> <u>disbursements</u> <u>(US\$ million)</u>
<u>1980</u>	
1st	-
2nd	0.4
<u>1981</u>	
1st	2.4
2nd	6.8
<u>1982</u>	
1st	16.2
2nd	27.1
<u>1983</u>	
1st	36.6
2nd	47.1
<u>1984</u>	
1st	53.9
2nd	58.9
<u>1985</u>	
1st	66.2
2nd	71.2
<u>1986</u>	
1st	76.2
2nd	80.0

THAILAND

IRRIGATION XI

Proposed Allocation of Loan Proceeds

	<u>Cost</u>		<u>Proposed loan</u>
	<u>Total</u>	<u>Foreign</u>	
	----- US\$ million -----		-----
<hr/>			
1. <u>Civil Works</u>			
Meklong	69.4	29.2	
Pattani	22.3	9.2	
Price increases expected	31.6	13.3	
Subtotal	<u>123.3</u>	<u>51.7</u>	<u>51.7</u>
Disbursements would be 50% of total expenditures for civil works contracts and on-farm development carried out by force account.			
2. <u>Equipment</u>			
Meklong	11.0	10.4	
Pattani	3.5	3.4	
Price increases expected	1.4	1.3	
Subtotal	<u>15.9</u>	<u>15.1</u>	<u>15.1</u>
Disbursements would be 100% of the foreign component of directly imported vehicles and equipment or the ex-factory price net of taxes of locally manufactured items and 65% of the total cost of locally procured imported items.			
3. <u>Consultants</u>			
Meklong	3.3	2.2	
Pattani	2.4	1.2	
Price increases expected	0.8	0.5	
Subtotal	<u>6.5</u>	<u>3.9</u>	<u>6.5</u>
Disbursements would be 100% of total expenditures.			
4. <u>Unallocated</u>			
Buildings	1.5	0.2	
Right-of-way	9.8	-	
Engineering & administration	11.9	1.8	
Physical contingencies	13.7	6.1	
Expected price increases	3.4	1.2	
Subtotal	<u>40.3</u>	<u>9.3</u>	<u>6.7</u>
<u>Total</u>	<u>186.0</u>	<u>80.0</u>	<u>80.0</u>

THAILAND

IRRIGATION XI

Irrigation Water Requirement

Meklong

Item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
<u>Rice</u>													
Evapotranspiration - mm	121	124	167	168	146	132	127	124	108	118	120	118	
Crop factor	1.5	1.10	1.25	1.35	1.30	1.25	1.05	1.10	1.25	1.35	1.30	1.25	
Crop consumptive use - mm	182	136	209	227	190	165	133	136	135	159	156	148	
Percolation - mm	20	30	30	30	30	30	25	12.5	15	15	15	12.5	
Effective rainfall - mm	-	-	-	41	79	74	77	98	146	151	40	-	706
Area irrigated - %	20	65	100	100	65	20	20	70	100	100	65	20	
Net consumptive use - mm	40	108	239	216	92	24	16	35	4	23	85	32	
Land preparation - mm	77	129	42	2	-	-	77	137	35	1	-	-	
Net irrig. requirement - mm	117	237	281	218	92	24	93	172	39	24	85	32	1,414
Net req. - 61,000 ha - MCM	71.4	144.6	171.4	133.0	56.1	14.6	56.7	104.9	23.8	14.6	51.9	19.5	862.5
Gross diversion req. - MCM	119.0	241.0	285.7	221.7	93.5	24.3	94.5	174.8	39.7	24.3	86.5	32.5	1,437.5
<u>Sugar cane</u>													
Evapotranspiration	121	124	167	168	146	132	127	124	108	118	120	118	
Crop factor	0.75	0.80	0.90	1.10	1.20	1.20	1.15	1.10	1.05	1.00	0.85	0.75	
Net consumptive use - mm	91	99	150	185	175	158	146	136	113	118	102	89	
Effective rainfall - mm	-	-	-	41	79	74	77	98	146	151	40	-	706
Area irrigated - %	80	80	80	80	100	100	100	100	100	100	100	80	
Preirrigation - mm	10	10	10	10	-	-	-	-	-	-	-	10	
Net irrig. req. - mm	83	89	130	125	96	84	69	38	-	-	62	81	857
Net req. - 5,000 ha - MCM	4.2	4.5	6.5	6.3	4.8	4.2	3.5	1.9	-	-	3.1	4.1	43.1
Gross diversion req. - MCM	7.5	8.0	11.6	11.25	8.6	7.5	6.3	3.4	-	-	5.5	7.3	77.0
Project diversion req. - MCM	126.5	249.0	297.3	233.0	102.1	31.8	100.8	178.2	39.7	24.3	92.0	39.8	1,514.5
Regulated flow at Vajiralongkorn Dam/a - MCM	1,045.0	1,125.0	1,217.0	1,116.0	764.0	521.0	627.0	588.0	301.0	349.0	618.0	591.0	8,862.0

/a Even if releases from Khao Laem were not included, flows would still be more than adequate.

THAILAND
IRRIGATION XI
Irrigation Water Requirement
Pattani

Item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
<u>Rice production</u>	(15,000 net ha with a cropping intensity of 100% wet season & 70% dry season)												
Evapotranspiration - mm	178	163	180	176	183	179	183	177	166	169	167	174	
Crop factor - average	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	
Consumptive use - mm	205	187	207	202	211	206	210	204	191	195	192	200	
Percolation - mm	16	14	31	30	31	30	31	31	15	16	15	16	
Effective rainfall - mm	69	9	19	30	97	89	85	96	115	161	185	161	1,116
Area irrigated - %	100	77	20	18	97	100	100	65	0	25	99	100	
Net consumptive use - mm	152	148	44	36	141	147	156	90	0	13	22	55	
Land preparation - mm	-	-	5	234	11	-	-	-	41	158	-	-	
Net irrig. requirement - mm	152	148	49	270	152	147	156	90	41	171	22	55	1,453
Cropping intensity - %	100	100	100	70	70	70	70	70	100	100	100	100	
Net req. - 15,000 ha - MCM	22.8	22.2	7.4	28.4	16.0	15.4	16.4	9.5	6.2	25.7	3.3	8.3	181.6
Gross diversion req. - MCM	38.0	37.0	12.3	47.3	26.6	25.7	27.3	15.8	10.3	42.8	5.5	13.8	302.4
Regulated flow at Pattani Dam - MCM	254.0	189.6	153.2	96.5	128.9	173.3	193.3	139.6	183.8	123.5	156.5	278.1	2,070.3

THAILAND
IRRIGATION XI

Physical Inputs and Unit Prices

	Unit	--Rainfed--		Irrigated		Sugarcane /a	Unit	Unit prices	
		Local trans-plant		Local trans-plant				Economic	Financial
		(wet)	(dry)	(wet)	(dry)				
MEKLONG									
Present									
Cultivation: Mechanical	% area	30	30	30	30	100	B/ha	725/1450	825/1650/b
Cultivation: Animal	% area	70	70	70	70	-	B/ha	430	425
Seed	kg	60	55	55	55	5,000	B/kg	3.9/0.275	2.4/0.28/c
Fertilizer: Ammophos	kg	30	30	50	70	-	B/kg	3.8	4.1
Fertilizer: Am. Sulfate	kg	-	-	-	-	860	B/kg	2.85	3.1
Fertilizer: Urea	kg	-	-	20	25	-	B/kg	4.4	5.1
Fertilizer: TSP	kg	-	-	-	-	-	B/kg	5.2	6.1
Fertilizer: KCL	kg	-	-	-	-	-	B/kg	3.3	3.6
Harvest: Mech. threshing	%	50	50	50	50	-	B/ton	35	40
Future Without Project									
Cultivation: Mechanical	% area	60	60	60	60	100	B/ha	725/2905	825/3300/b
Cultivation: Animal	% area	40	40	40	40	-	B/ha	430	425
Seed	kg	60	55	55	55	5,000	B/kg	5.9/0.495	3.5/0.415/c
Fertilizer: Ammophos	kg	30	65	80	90	-	B/kg	5.0	5.45
Fertilizer: Am. Sulfate	kg	-	-	-	-	1,025	B/kg	3.6	3.9
Fertilizer: Urea	kg	-	-	30	30	-	B/kg	5.5	6.5
Fertilizer: TSP	kg	-	-	-	-	130	B/kg	7.25	8.55
Fertilizer: KCL	kg	-	-	-	-	100	B/kg	4.20	4.6
Harvest: Mech. threshing	%	65	65	65	65	-	B/ton	35	40
Future With Project									
Cultivation: Mechanical	% area	-	90	90	90	100	B/ha	725/2905	825/3300/b
Cultivation: Animal	% area	-	10	10	10	-	B/ha	430	425
Seed	kg	-	45	45	45	5,000	B/kg	5.9/0.495	3.5/0.415/c
Fertilizer: Ammophos	kg	-	95	190	220	-	B/kg	5.0	5.45
Fertilizer: Am. Sulfate	kg	-	-	-	-	1,285	B/kg	3.6	3.9
Fertilizer: Urea	kg	-	35	65	75	-	B/kg	5.5	6.5
Fertilizer: TSP	kg	-	-	-	-	195	B/kg	7.25	8.55
Fertilizer: KCL	kg	-	-	-	-	150	B/kg	4.2	4.6
Harvest: Mech. threshing	%	-	75	75	75	-	B/ton	35	40
PATTANI									
Present									
Cultivation: Mechanical	% area	15	-	-	-	-	B/ha	825	935
Cultivation: Animal	% area	85	-	-	-	-	B/ha	430	425
Seed	kg	60	-	-	-	-	B/kg	3.9	2.4
Fertilizer: Ammophos	kg	30	-	-	-	-	B/kg	3.9	4.1
Fertilizer: Urea	kg	-	-	-	-	-	B/kg	4.5	5.1
Harvest: Mech. threshing	%	-	-	-	-	-	B/ton	-	-
Future Without Project									
Cultivation: Mechanical	% area	40	-	-	-	-	B/ha	800	910
Cultivation: Animal	% area	60	-	-	-	-	B/ha	430	425
Seed	kg	60	-	-	-	-	B/kg	5.9	3.5
Fertilizer: Ammophos	kg	45	-	-	-	-	B/kg	5.1	5.45
Fertilizer: Urea	kg	-	-	-	-	-	B/kg	5.65	6.5
Harvest: Mech. threshing	%	15	-	-	-	-	B/ton	35	40
Future With Project									
Cultivation: Mechanical	% area	-	60	60	60	-	B/ha	765	870
Cultivation: Animal	% area	-	40	40	40	-	B/ha	430	425
Seed	kg	-	45	45	45	-	B/kg	5.9	3.5
Fertilizer: Ammophos	kg	-	50	95	125	-	B/kg	5.1	5.45
Fertilizer: Urea	kg	-	20	35	45	-	B/kg	5.65	6.5
Harvest: Mech. threshing	%	-	35	35	35	-	B/ton	35	40

/a Physical inputs for plant crop and 2 ratoon cycle.

/b Per hectare costs for rice/sugarcane.

/c Seed/planting material costs for rice/sugarcane.

THAILAND

IRRIGATION XI

Financial Crop Budgets

MEKLONG

	Yield (ton/ha)	Price (B/ton)	Gross value (B/ha)	Seed -----	Fertilizer -----	Agro- chemicals (B/ha)	Other /a -----	Total -----	Net value of production (B/ha)
<u>Present</u>									
<u>Wet Season</u>									
Rainfed local paddy	2.2	2,400	5,280	145	125	30	320	620	4,660
Irrigated local paddy	2.5	2,400	6,000	130	125	30	330	615	5,385
Irrigated HYV	2.8	2,400	6,720	130	305	30	335	800	5,920
<u>Dry Season</u>									
HYV paddy	3.0	2,400	7,200	130	415	75	310	930	6,270
Flood area local paddy	2.2	2,400	5,280	145	125	30	320	620	4,660
Sugarcane	55.0	280	15,400	470	890	435	3,885	5,680	9,720
<u>Future Without Project</u>									
<u>Wet Season</u>									
Rainfed local paddy	2.5	3,500	8,750	210	165	45	590	1,010	7,740
Irrigated local paddy	2.8	3,500	9,800	190	355	135	600	1,280	8,520
Irrigated HYV	3.2	3,500	11,200	190	630	135	610	1,565	9,635
<u>Dry Season</u>									
HYV paddy	3.3	3,500	11,500	190	685	200	580	1,655	9,895
Flood area local paddy	2.5	3,500	8,750	210	165	45	590	1,010	7,740
Flood area HYV paddy	3.2	3,500	11,200	190	685	200	590	1,665	9,535
Sugarcane	75.0	415	31,125	690	1,855	450	5,645	8,640	22,485
<u>Future With Project</u>									
<u>Wet Season</u>									
Irrigated local paddy	3.5	3,500	12,250	160	745	335	875	2,115	10,135
Irrigated HYV	4.0	3,500	14,000	160	1,460	335	890	2,845	11,155
<u>Dry Season</u>									
HYV paddy	4.2	3,500	14,700	160	1,685	400	870	3,115	11,585
Flood area paddy	4.0	3,500	14,000	160	1,685	335	890	3,070	10,930
Sugarcane	90.0	415	37,350	690	2,455	980	6,555	10,680	26,670

/a Other for sugar includes transportation, interest on production credit, land tax, mechanized land preparation and threshing cost, various sugar fees and taxes.
Other for rice includes mechanized land preparation and threshing/winnowing and land tax.

THAILAND
IRRIGATION XI

Financial Crop Budgets

PATTANI

	Yield (ton/ha)	Price (B/ton)	Gross value (B/ha)	Seed -----	Fertilizer	Agro- chemicals (B/ha)	Other -----	Total	Net value of production (B/ha)
<u>Present</u>									
<u>Wet Season</u>									
Rainfed local paddy	1.4	2,400	3,360	145	125	-	170	440	2,920
<u>Future Without Project</u>									
<u>Wet Season</u>									
Rainfed local paddy	1.6	3,500	5,600	210	245	-	405	860	4,740
<u>Future With Project</u>									
<u>Wet Season</u>									
Irrigated local paddy	2.5	3,500	8,750	160	400	200	590	1,350	7,400
Irrigated HYV	3.0	3,500	10,500	160	745	200	595	1,700	8,800
<u>Dry Season</u>									
HYV paddy	3.5	3,500	12,250	160	975	265	570	1,970	10,280

THAILAND
IRRIGATION XI

Crop Labor Requirements by Activity /a

	<u>Meklong</u>					<u>Pattani</u>			
	<u>Rice</u>					<u>Rice</u>			
	<u>Rainfed</u>	<u>Irrigated</u>			<u>Sugar/b,/c</u>	<u>Rainfed</u>	<u>Irrigated</u>		
		<u>Native</u>	<u>Wet</u>	<u>Dry</u>			<u>Native</u>	<u>Wet</u>	<u>Dry</u>
		<u>HYV</u>	<u>HYV</u>			<u>HYV</u>	<u>HYV</u>		
<u>Present</u>									
Land preparation	19	19	19	19	60	22	-	-	-
Nursery	3	3	3	4	-	3	-	-	-
Plant/transplant	27	27	27	27	31	27	-	-	-
Management	4	10	10	13	119	3	-	-	-
Harvest	32	33	34	35	105	36	-	-	-
<u>Total</u>	<u>85</u>	<u>92</u>	<u>93</u>	<u>98</u>	<u>315</u>	<u>91</u>	<u>-</u>	<u>-</u>	<u>-</u>
<u>Future Without Project</u>									
Land preparation	13	13	13	13	40	20	-	-	-
Nursery	3	3	3	4	-	3	-	-	-
Plant/transplant	27	27	27	27	31	27	-	-	-
Management	5	12	12	15	98	4	-	-	-
Harvest	33	35	36	38	132	38	-	-	-
<u>Total</u>	<u>81</u>	<u>90</u>	<u>91</u>	<u>97</u>	<u>301</u>	<u>92</u>	<u>-</u>	<u>-</u>	<u>-</u>
<u>Future With Project</u>									
Land preparation	-	11	11	11	20	-	15	15	15
Nursery	-	3	3	4	-	-	3	3	4
Plant/transplant	-	27	27	27	31	-	27	27	27
Management	-	26	26	28	116	-	20	20	25
Harvest	-	37	38	39	159	-	38	40	42
<u>Total</u>	<u>-</u>	<u>104</u>	<u>105</u>	<u>109</u>	<u>326</u>	<u>-</u>	<u>103</u>	<u>105</u>	<u>113</u>

/a Does not include labor inputs for operating machinery.

/b Total labor inputs for plant crop and two ratoons.

/c Harvest labor does not include loading and transport.

THAILAND

IRRIGATION XI

Monthly Labor Requirements by Crop /a
(Man-days/month/ha)

		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
<u>Meklong</u>														
<u>Wet Season</u>														
Rainfed rice	P	12	-	-	-	5	18	17	10	1	1	1	20	85
	FW	12	-	-	-	5	16	15	10	1	1	1	20	81
Irrigated rice	P	11	-	-	-	5	21	20	7	2	2	2	22	92
	FW	12	-	-	-	5	19	19	7	2	2	2	22	90
	FW	-	-	-	-	-	-	16	29	9	10	29	12	105
<u>Dry Season</u>														
Irrigated rice	P	22	31	4	4	26	11	-	-	-	-	-	-	98
	FW	20	31	4	4	26	12	-	-	-	-	-	-	97
	FW	18	31	7	7	29	17	-	-	-	-	-	-	109
Sugar cane /b	P	15	15	25	23	8	5	4	4	1	1	1	7	109
	FW	15	16	26	23	8	5	4	4	1	1	1	7	111
	FW	19	23	28	23	8	5	4	4	1	1	1	10	127
<u>Pattani</u>														
<u>Wet Season</u>														
Rainfed rice	P	1	9	32	-	-	-	-	3	12	25	8	1	91
	FW	2	11	32	-	-	-	-	3	12	23	8	1	92
Irrigated rice	FW	5	11	32	-	-	-	-	-	7	27	18	5	105
<u>Dry Season</u>														
Irrigated rice	FW	-	-	3	24	25	10	8	32	11	-	-	-	113

/a Does not include man-day inputs for operating machinery.

/b Labor inputs for plant crop. Inputs for ratoon crops lower by 10% to 20%.

THAILAND
IRRIGATION XI

Farm Budgets: Meklong

	2.0 ha rice farm			4.0 ha rice farm			5.0 ha sugar farm		
	Present	Future w/o project /a	Future with project	Present	Future w/o project /a	Future with project	Present	Future w/o project /b	Future with project
Land area (ha)	2.0	2.0	2.0	4.0	4.0	4.0	5.0	5.0	5.0
Cropped area									
Wet season:									
Local rice (ha)	2.0	2.0	0.5	4.0	4.0	1.0	-	-	-
HYV rice (ha)	-	-	1.5	-	-	3.0	-	-	-
Dry season:									
HYV rice (ha)	-	-	1.8	-	-	3.6	-	-	-
Sugarcane (ha)	-	-	-	-	-	-	5.0	5.0	5.0
Total	2.0	2.0	3.8	4.0	4.0	7.6	5.0	5.0	5.0
Cropping intensity (%)	100	100	190	100	100	190	100	100	100
Crop production									
Wet season:									
Local rice (kg)	4,400	5,000	1,750	8,800	10,000	3,500	-	-	-
HYV rice (kg)	-	-	6,000	-	-	12,000	-	-	-
Dry season:									
HYV rice (kg)	-	-	7,560	-	-	15,100	-	-	-
Sugarcane (ton)	-	-	-	-	-	-	275.0	375.0	450.0
Total labor requirements (man-days) /c	170	162	406	340	324	812	545	555	635
Gross value of production (Baht) /d	10,560	17,500	53,585	21,120	35,000	107,170	77,000	155,625	186,750
Production costs (Baht) /e	1,240	2,020	10,930	2,480	4,040	21,865	28,400	43,200	53,400
Hired labor cost (Baht) /f	-	-	-	1,000	600	4,825	5,520	7,880	7,440
Interest on production credit (Baht) /g	105	170	525	210	340	1,050	2,725	4,145	5,125
Net Crop Income (Baht)	9,215	15,310	42,130	17,430	30,020	79,430	40,355	100,400	120,785
Other income (Baht) /h	6,500	6,500	2,000	4,200	4,200	-	-	-	-
Subtotal Income (Baht)	15,715	21,810	44,130	21,630	34,220	79,430	40,355	100,400	120,785
Capital cost recovery (Baht) /i	-	-	1,960	-	-	3,920	-	-	4,900
O&M main system (Baht) /j	-	-	600	-	-	1,200	-	-	1,500
O&M on-farm (Baht) /k	-	-	160	-	-	320	-	-	400
Taxes (Baht)	60	60	60	125	125	125	155	155	155
Net farm income (Baht)	15,655	21,750	41,350	21,505	34,095	73,865	40,200	100,245	113,830
Per capita farm income (Baht) (6 persons/family)	2,610	3,625	6,890	3,585	5,680	12,310	6,700	16,710	18,970

/a Both 2.0 ha and 4.0 ha farms are assumed to be rainfed in future without project. Supplemental wet-season irrigation would increase net crop incomes by about 10%.

/b Sugar farm budget based on 3-year cycle with 1/3 of area in plant crop, 1/3 in first ratoon and 1/3 second ratoon for any given year. Supplementary wet-season irrigation assumed for future without project.

/c From Annex 3, Table 5.

/d From Annex 3, Table 2.

/e From Annex 3, Tables 1 and 2.

/f B 25/day for rice farms and B 30/day for sugar farms.

/g Present and future without project: for rice farmers, 15% of production costs from institutional sources at 1%/month for 6 months and 50% of production costs from noninstitutional sources at 2.5%/month for 6 months; for sugar farmers, 50% of production costs at 1%/month for 12 months and 15% of production costs at 2%/month for 12 months. Future with project: 80% of production costs from BAAC at 1%/month for 6 months (rice) and 12 months (sugar).

/h Based on 1975 survey findings.

/i 50% of on-farm development cost repaid over 12 years at 12% interest.

/j B 300/ha.

/k B 80/ha.

THAILAND
IRRIGATION XI

Pattani: Farm Budgets

	1.0 ha Farm			2.5 ha Farm			4.0 ha Farm /a		
	Present	Future		Present	Future		Present	Future	
		Without project	With project		Without project	With project		Without project	With project
Inside Project Area									
Land area	1.0	1.0	1.0	2.5	2.5	2.5	3.0	3.0	3.0
Cropped Area									
Wet season: Local rice (ha)	1.0	1.0	0.5	2.5	2.5	1.25	3.0	3.0	1.5
HYV rice (ha)	-	-	0.5	-	-	1.25	-	-	1.5
Dry season: HYV rice (ha)	-	-	0.7	-	-	1.75	-	-	2.1
Total (ha)	1.0	1.0	1.7	2.5	2.5	4.25	3.0	3.0	5.1
Cropping intensity (%)	100	100	170	100	100	170	100	100	170
Crop Production									
Wet season: Local rice (kg)	1,400	1,600	1,250	3,500	4,000	3,125	4,200	4,800	3,750
HYV rice (kg)	-	-	1,500	-	-	3,750	-	-	4,500
Dry season: HYV rice (kg)	-	-	2,450	-	-	6,125	-	-	7,350
Total labor requirement (man-days) /b	91	92	184	228	230	460	273	276	549
Gross value of production (B) /c	3,360	5,600	18,200	8,400	14,000	45,500	10,080	16,800	54,600
Production costs (B) /d	440	860	2,905	1,100	2,150	7,260	1,320	2,580	8,710
Hired labor costs (B) /e	-	-	-	160	160	320	540	480	735
Interest on production credit (B) /f	35	70	140	90	180	350	110	215	420
Net crop income inside project (B)	2,885	4,670	15,155	7,050	11,510	37,570	8,110	13,525	44,735
Outside Project Area									
Land area (ha)	-	-	-	-	-	-	1.0	1.0	1.0
Net crop income outside project (B) /g	-	-	-	-	-	-	3,115	7,890	7,890
Net Agricultural Income (B)	2,885	4,670	15,155	7,050	11,510	37,570	11,225	21,415	52,625
Other income (B) /h	4,000	4,000	2,800	3,600	3,600	800	1,200	400	400
Subtotal income (B)	6,885	8,670	17,955	10,650	15,110	38,370	12,425	21,815	53,025
Capital cost recovery (B) /i	-	-	465	-	-	1,160	-	-	1,395
O&M main system (B) /j	-	-	300	-	-	750	-	-	900
O&M on-farm (B) /k	-	-	80	-	-	200	-	-	240
Taxes (B)	30	30	30	75	75	75	125	125	125
Net farm income (B)	6,855	8,640	17,080	10,575	15,035	36,185	12,300	21,690	50,365
Per capita Net Farm Income (B) (8 persons/family)	855	1,080	2,135	1,320	1,880	4,525	1,540	2,710	6,295

/a 3.0 ha rice holding in project area plus 1.0 ha rubber outside project area.

/b Annex 3, Table 5.

/c Annex 3, Table 3.

/d Annex 3, Tables 1 and 3.

/e B 20/day.

/f Present and future without project: 15% of production costs from institutional sources at 1%/month for 6 months and 50% of production costs from noninstitutional sources at 2.5%/month for six months. Future with project: 80% of production costs from BAAC @ 1%/month for six months.

/g Earnings from 1.0 ha rubber holding outside project area.

/h Earnings from rubber tapping.

/i 50% of on-farm development cost repaid over 12 years at 12% interest.

/j B 300/ha.

/k B 80/ha.

ANNEX 4
Table 1

CONVERSION FACTORS AND NATIONAL PARAMETERS

Standard conversion factor	0.79
Conversion factor for - Consumption	0.96
- Middleman's margin	0.69/a
- Fertilizer	0.92
- Insecticide	0.88
- Construction	0.74
- Government services	0.65/b
- Milling margin	0.72
- Agricultural machinery	0.88
- Draft animals	1.01
Economic accounting rate of interest (EARI)	0.118

/a Weighted average of conversion factors for trade (0.47) and transport (0.76), assuming middleman's profit accounts for 25% and transport/handling costs account for 75% of his margin.

/b Weighted average of conversion factors for industry (0.80) and trade, assuming milling cost accounts for 75% and profit accounts for 25% of the miller's margin.

THAILAND

IRRIGATION XI

Net Value of Production at Full Project Development

	Area (['] 000/ha)	Yield (ton/ha)	Production (['] 000 ton)	Farm-gate price (B/ton)	Gross value of production	Production costs	Net value of production B million	Imputed labor costs	Net value of production after labor costs
MEKLONG									
<u>Future Without Project</u>									
Wet season: Paddy, native	49.1	2.6	127.7	5,900	753.4	55.2	698.2	103.1	595.1
Paddy, HYV	10.9	3.2	34.9	5,900	205.8	16.6	189.2	25.0	164.2
Dry season: Paddy, HYV	16.5	3.3	54.0	5,900	318.6	26.8	291.8	38.0	253.8
Sugarcane	6.0	75.0	450.0	495	222.8	40.8	182.0	16.7	165.3
<u>Total</u> (Cropping Intensity)	<u>82.5</u> 108%		<u>666.6</u>		<u>1,500.6</u>	<u>139.4</u>	<u>1,361.2</u>	<u>182.8</u>	<u>1,178.4</u>
<u>Future With Project</u>									
Wet season: Paddy, native	15.2	3.5	53.2	5,900	313.9	30.0	283.9	39.9	244.0
Paddy, HYV	45.8	4.0	183.2	5,900	1,080.9	120.3	960.6	122.5	838.1
Dry season: Paddy, HYV	55.0	4.2	231.0	5,900	1,362.9	159.1	1,203.8	149.9	1,053.9
Sugarcane	5.0	90.0	450.0	495	222.8	41.9	180.9	15.9	165.0
<u>Total</u> (Cropping Intensity)	<u>121.0</u> 190%		<u>917.4</u>		<u>2,980.5</u>	<u>351.3</u>	<u>2,629.2</u>	<u>328.2</u>	<u>2,301.0</u>
<u>Increment</u>	<u>38.5</u>		<u>250.8</u>		<u>1,479.9</u>	<u>211.9</u>	<u>1,268.0</u>	<u>145.4</u>	<u>1,122.6</u>
PATTANI									
<u>Future Without Project</u>									
Paddy, native (Cropping Intensity)	16.0 (100%)	1.6	25.6	5,900	151.0	14.5	136.5	30.6	105.9
<u>Future With Project</u>									
Wet season: paddy, native	7.5	2.5	18.8	5,900	110.9	9.7	101.2	16.5	84.7
paddy, HYV	7.5	3.0	22.5	5,900	132.8	12.0	120.8	16.5	104.3
Dry season: paddy, HYV	10.5	3.5	36.8	5,900	217.1	19.7	197.4	24.7	172.7
<u>Total</u> (Cropping Intensity)	<u>25.5</u> (170%)		<u>78.1</u>		<u>460.8</u>	<u>41.4</u>	<u>419.4</u>	<u>57.7</u>	<u>361.7</u>
<u>Increment</u>	<u>9.5</u>		<u>52.5</u>		<u>309.8</u>	<u>26.9</u>	<u>282.9</u>	<u>27.1</u>	<u>255.8</u>
TOTAL PROJECT AREA									
Future Without Project	98.5		692.2		1,651.6	153.9	1,497.7	213.4	1,284.3
Future With Project	146.5		995.5		3,441.3	392.7	3,048.6	385.9	2,662.7
<u>Increment</u>	<u>48.0</u>		<u>303.3</u>		<u>1,789.7</u>	<u>238.8</u>	<u>1,550.9</u>	<u>172.5</u>	<u>1,378.4</u>

THAILAND

IRRIGATION XI

Total Monthly Labor Requirement
('000 man-days)

		Area (ha)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
<u>MEKLONG</u>															
<u>Wet Season</u>															
Rainfed paddy	P	32,900	394.9	-	-	-	164.5	592.2	559.3	329.0	32.9	32.9	32.9	658.0	2,796.5
	W	32,900	394.9	-	-	-	164.5	526.4	493.5	329.0	32.9	32.9	32.9	658.0	2,664.9
Irrigated paddy (N)	P	27,100	301.0	-	-	-	135.5	569.1	542.0	189.7	54.2	54.2	54.2	599.0	2,498.9
	W	16,200	194.4	-	-	-	81.0	307.8	307.8	113.4	32.4	32.4	32.4	356.4	1,458.0
	W	15,200	-	-	-	-	-	-	243.2	440.9	136.9	152.0	440.9	182.4	1,596.3
Irrigated paddy (HYV)	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	W	10,900	141.7	-	-	-	54.5	207.1	207.1	76.3	21.8	21.8	21.8	250.7	1,002.8
	W	45,800	-	-	-	-	-	-	732.8	1,328.3	412.1	458.0	1,328.1	641.2	4,900.5
<u>Dry Season</u>															
Paddy (HYV)	P	8,450	100.9	111.9	18.8	113.8	149.7	37.9	-	-	-	70.0	115.0	50.0	768.0
	W	16,500	255.0	361.5	51.0	146.0	369.0	138.0	-	-	-	60.0	100.0	40.0	1,520.5
	W	55,000	990.0	1,705.0	385.0	385.0	1,595.0	935.0	-	-	-	-	-	-	5,995.0
Sugarcane	P	6,000	90.0	90.0	150.0	138.0	48.0	30.0	24.0	24.0	6.0	6.0	6.0	42.0	654.0
	W	6,000	90.0	96.0	156.0	138.0	48.0	30.0	24.0	24.0	6.0	6.0	6.0	42.0	666.0
	W	5,000	95.0	115.0	140.0	115.0	40.0	25.0	20.0	20.0	5.0	5.0	5.0	50.0	635.0
Subtotal Meklong	P	-	886.7	201.9	168.8	251.8	497.7	1,229.2	1,125.3	542.7	93.1	163.1	208.1	1,349.0	6,717.4
	W	-	1,075.9	457.5	207.0	284.0	717.0	1,209.3	1,032.4	542.7	93.1	153.1	193.1	1,347.1	7,312.2
	W	-	1,085.0	1,820.0	525.0	500.0	1,635.0	960.0	996.0	1,789.2	554.0	615.0	1,774.0	873.6	13,126.8
<u>PATTANI</u>															
<u>Wet Season</u>															
Rainfed paddy	P	16,000	16.0	144.0	512.0	-	-	-	-	48.0	192.0	400.0	128.0	16.0	1,456.0
	W	16,000	32.0	176.0	512.0	-	-	-	-	48.0	192.0	368.0	128.0	16.0	1,472.0
Irrigated paddy (N)	W	7,500	37.5	75.0	232.5	-	-	-	-	-	52.5	202.5	135.0	37.5	772.5
	W	7,500	37.5	82.5	240.0	-	-	-	-	-	52.5	202.5	135.0	37.5	787.5
Irrigated paddy (HYV)	W	7,500	37.5	82.5	240.0	-	-	-	-	-	52.5	202.5	135.0	37.5	787.5
	W	7,500	37.5	82.5	240.0	-	-	-	-	-	52.5	202.5	135.0	37.5	787.5
<u>Dry Season</u>															
Irrigated paddy (HYV)	W	10,500	-	-	31.5	252.0	262.5	105.0	84.0	336.0	115.5	-	-	-	1,186.5
Subtotal Pattani	P	-	16.0	144.0	512.0	-	-	-	-	48.0	192.0	400.0	128.0	16.0	1,456.0
	W	-	32.0	176.0	512.0	-	-	-	-	48.0	192.0	368.0	128.0	16.0	1,472.0
	W	-	75.0	157.5	504.0	252.0	262.5	105.0	84.0	336.0	220.5	405.0	270.0	75.0	2,746.5
<u>Total Project</u>															
Total Project	P	-	902.7	345.9	680.8	251.8	497.7	1,229.2	1,125.3	590.7	285.1	563.1	336.1	1,365.0	8,073.4
	W	-	1,107.9	633.5	719.0	284.0	717.0	1,209.3	1,032.4	590.7	285.1	521.1	321.1	1,363.1	8,784.2
	W	-	1,160.0	1,977.5	1,029.0	752.0	1,897.5	1,065.0	1,080.0	2,125.2	774.5	1,020.0	2,044.0	948.6	15,873.3

THAILAND

IRRIGATION XI

Economic Costs and Benefits
(B million)

Year	Pattani			Meklong			Total project		
	<u>Incremental costs</u> Capital	O&M	Incremental benefits	<u>Incremental costs</u> Capital	O&M	Incremental benefits	<u>Incremental costs</u> Capital	O&M	Incremental benefits
1 1980	78.6	-	-	189.1	-	-	267.7	-	-
2 1981	190.9	0.4	6.4	435.6	0.8	56.1	625.5	1.2	62.5
3 1982	189.7	1.2	12.8	323.9	3.1	89.8	513.6	4.3	102.6
4 1983	64.4	3.3	25.6	272.8	8.1	168.4	337.2	11.4	194.0
5 1984	67.4	4.9	64.0	245.0	15.4	280.7	312.4	20.3	376.4
6 1985	-	5.8	115.1	177.6	22.2	505.2	177.6	28.0	620.3
7 1986	-	5.8	153.5	-	25.3	673.6	-	31.1	827.1
8 1987	-	5.8	184.1	-	25.3	808.3	-	31.1	992.4
9 1988	-	5.8	212.4	-	25.3	931.8	-	31.1	1,144.2
10 1989	-	5.8	243.0	-	25.3	1,032.8	-	31.1	1,275.8
11-30 1990-2010	-	5.8	255.8	-	25.3	1,122.6	-	31.1	1,378.4
IRR:		23%			35%			32%	

THAILAND

IRRIGATION XI

Economic Sensitivity Analysis

Variable	Meklong			Pattani		
	Appraisal value	Crossover value /a	% Change	Appraisal value	Crossover value /a	% Change
Yields at full development						
Wet season	3.9 t/ha	2.6 t/ha	- 33	2.75 t/ha	1.8 t/ha	- 35
Dry season	4.2 t/ha	2.8 t/ha	- 33	3.50 t/ha	2.3 t/ha	- 35
Dry season cropping intensity (rice)	83%	19%	- 77	70%	12.5%	- 82
World market price of rice (5% broken, f.o.b. Bangkok, 1990)	\$480/t	\$216/t	- 55	\$480/t	\$262/t	- 45
Construction costs	\$82.2 m	\$320.6 m	+290	\$29.6 m	\$68.3 m	+130
Development period	11 years	23 years	+109	11 years	21 years	+ 90

/a Value of variable tested for which the net present value (discounted at 12%) is zero.

THAILAND

IRRIGATION XI

Economic Costs and Benefits including Sunk Costs
(B million)

Year	<u>Pattani-Right Main Canal</u>				<u>Pattani-Total Stage I</u>				<u>Meklong</u>			
	Past costs /a	Future Capital	O&M	Incremental benefits	Past costs /a	Future Capital	O&M	Incremental benefits	Past costs /a	Future Capital	O&M	Incremental benefits
1 1964	-	-	-	-	-	-	-	-	2.9	-	-	-
2 1965	-	-	-	-	-	-	-	-	6.0	-	-	-
3 1966	-	-	-	-	-	-	-	-	14.2	-	-	-
4 1967	-	-	-	-	-	-	-	-	26.9	-	-	-
5 1968	15.2	-	-	-	38.1	-	-	-	21.5	-	-	-
6 1969	15.0	-	-	-	37.7	-	-	-	14.4	-	-	-
7 1970	13.6	-	-	-	34.0	-	-	-	27.5	-	-	-
8 1971	17.5	-	-	-	31.4	-	-	-	110.0	-	-	-
9 1972	11.3	-	-	-	28.4	-	-	-	81.4	-	-	-
10 1973	9.4	-	-	-	23.5	-	-	-	107.1	-	-	-
11 1974	18.8	-	-	-	47.1	-	-	-	46.4	-	-	-
12 1975	21.0	-	-	-	52.7	-	-	-	81.1	-	-	-
13 1976	37.2	-	-	-	93.2	-	-	-	119.3	-	-	-
14 1977	20.8	-	-	-	52.0	-	-	-	45.1	-	-	-
15 1978	14.2	-	-	-	35.5	-	-	-	111.2	-	-	-
16 1979	29.4	-	-	-	91.1	-	-	-	75.6	-	-	-
17 1980	-	78.6	-	-	-	78.6	-	-	-	189.1	-	-
18 1981	-	190.9	0.4	6.4	-	203.0	0.4	6.4	-	435.6	0.8	56.1
19 1982	-	189.7	1.2	12.8	-	374.7	1.6	12.8	-	323.9	3.1	89.8
20 1983	-	64.4	3.3	25.6	-	349.4	5.1	51.2	-	272.8	8.1	168.4
21 1984	-	67.4	4.9	64.0	-	352.4	9.6	115.1	-	245.0	15.4	280.7
22 1985	-	-	5.8	115.1	-	189.1	14.8	243.0	-	177.6	22.2	505.2
23 1986	-	-	5.8	153.5	-	-	17.3	383.7	-	-	25.3	673.6
24 1987	-	-	5.8	184.1	-	-	17.3	491.1	-	-	25.3	808.3
25 1988	-	-	5.8	212.4	-	-	17.3	580.7	-	-	25.3	931.8
26 1989	-	-	5.8	243.0	-	-	17.3	667.6	-	-	25.3	1,032.8
27 1990	-	-	5.8	255.8	-	-	17.3	741.8	-	-	25.3	1,122.6
28-47 1991-2010	-	-	5.8	255.8	-	-	17.3	767.4	-	-	25.3	1,122.6
IRR:		13%				14%				15%		

/a Pattani net benefits discounted from 1968; Meklong from 1964.

THAILAND

ELEVENTH IRRIGATION PROJECT

Disbursement for Force Account Construction

1. RID's internal cost control system is basically designed to record expenditures incurred by its various functional divisions and is primarily concerned with reconciling budget allocation and actual cost expenditures. Although project specific accounts accurately record the disbursement of loan proceeds for equipment, materials and consulting services, difficulties are encountered in obtaining accurate cost data for specific project works carried out by force account.

2. Force account work for the proposed project would include construction of drains, rehabilitation of existing canals, and on-farm development (about 25% of the total area of 81,000 ha). No disbursement would be made for drain construction or canal rehabilitation because of the difficulties of maintaining accurate cost records for widely scattered construction operations. Disbursement for on-farm development would be at 50% of an agreed fixed price per hectare. Estimates based on similar work in the ongoing Bank projects and confirmed by current contract prices indicate costs for on-farm development, exclusive of equipment depreciation of US\$540/ha for Meklong and US\$280/ha for Pattani. Disbursement would therefore be US\$270/ha for Meklong and US\$140/ha for Pattani. In the second and fourth years of this project, RID would maintain detailed accounts for areas of about 500 ha in each project to check the above agreed prices and in consultation with the Bank the prices would be revised if necessary. Documentation to support disbursement requests would identify the location of the completed blocks and their areas. Experience has shown, that on Bank-financed projects, RID maintains accounts and reliable records on the status of on-farm development works and these can be readily verified by Bank supervision missions during field inspections.

THAILAND

IRRIGATION XI PROJECT

Schedule of Early Events

A c t i v i t y	Responsibility	Target date
<u>1. General</u>		
(a) Submit proposal for collection of O&M fees	RID	12/80
(b) Appoint consultants for both project components	RID	12/79
<u>2. Civil Works</u>		
(a) Complete surveys and mapping		
- Center canal area	RID	5/80
- Left Canal area	RID	11/80
(b) Complete land classification		
- Center canal	RID	4/80
- Left canal	RID	9/80
(c) Begin construction of IR canal extension - Meklong	RID	12/79
(d) Award contract for layout and design - right main canal - Pattani	RID	2/80

THAILAND

IRRIGATION XI PROJECT

Related Documents and Data Available in the Project File

A. General reports and studies on the agriculture sector

- A1 - World Bank. "Thailand Irrigation Program Review," Report No. 1397A-TH, December 1976.
- A2 - World Bank Draft Report. "Thailand Agriculture Sector Memorandum," Report No. 2554-TH, June 12, 1979.

B. General reports and studies relating to the project

- B1 - "Feasibility Report on the Greater Meklong Multipurpose Project, Thailand, Second Stage Development for Irrigation, Flood Control, and Hydro-Power," Royal Irrigation Development, August 1968.
- B2 - "Pattani River Project, Feasibility Report," Sverdrup & Parcel and Associates, Inc., December 1969.
- B3 - "Thailand: Appraisal of the Ban Chao Nen Hydroelectric Power Project," World Bank Report No. 291A-TH, March 1974.
- B4 - "South Thailand Regional Planning Study," Hunting Technical Services Ltd., 1974.
- B5 - "Greater Meklong Irrigation Project," ILACO, November 1974.
- B6 - "Pattani Multipurpose Project, Phase A, Summary Update Feasibility Report," Sverdrup & Parcel and Associates, Inc., and Frederiksen, Kamine and Associates, Inc., April 1977.
- B7 - "Thailand: Appraisal of the Pattani Hydro-Electric Project," World Bank Report No. 1447-TH, July 1977.
- B8 - "Interim Report on Master Plan Study of the Greater Mae Klong River Basin Development Project," Japan International Cooperation Agency, March 1978.
- B9 - "Meklong Irrigation Improvement Project, Project Preparation Report for a Part of the Greater Mae Klong Irrigation Project Area," ILACO/EMPIRE M&T, January 1979.

C. Selected Working Papers

- C1 - "Engineering Studies," J.W. Robins, June 1979.

**THAILAND
IRRIGATION XI
Implementation Schedule
Meklong**

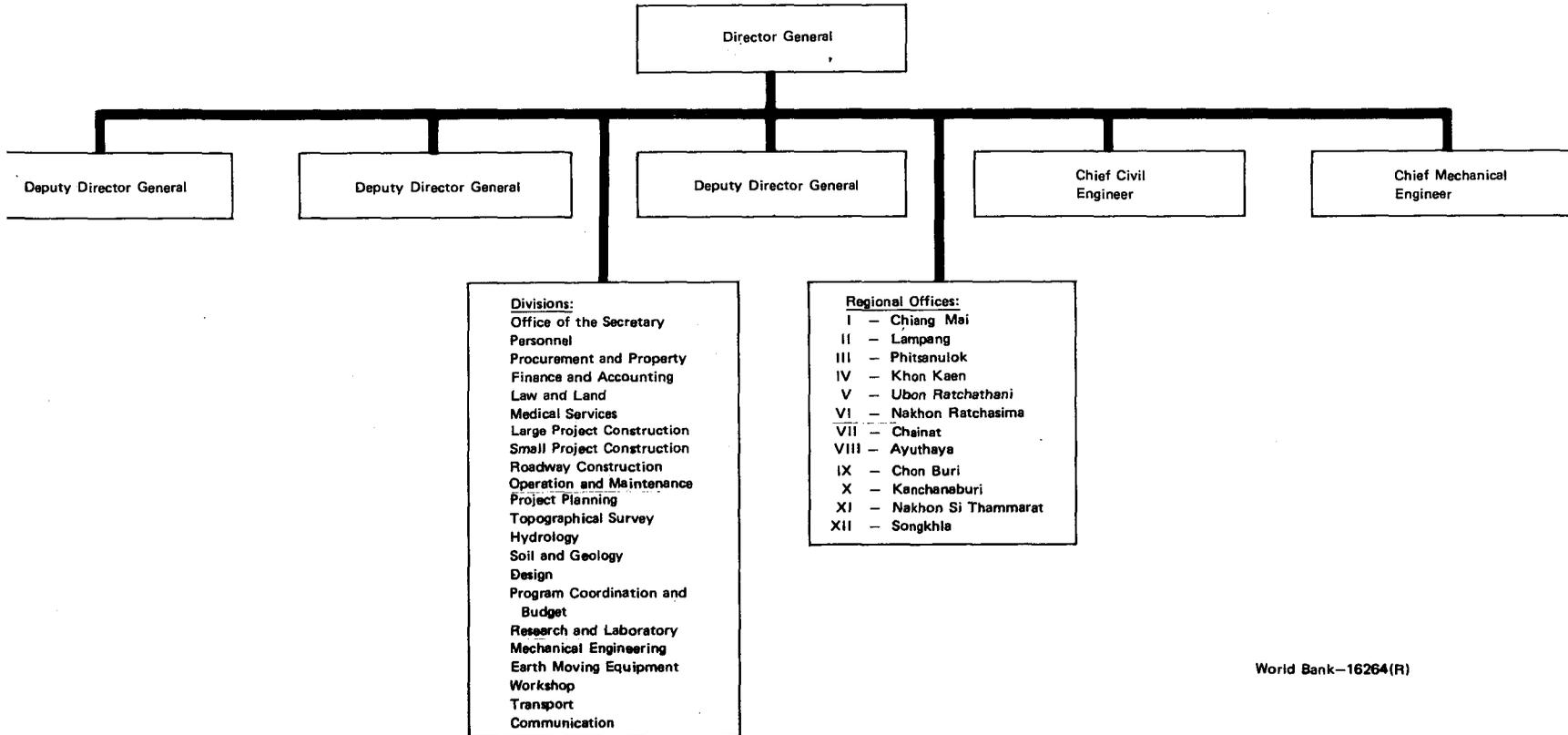
ITEM	Season	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
	Calendar Year	1980		1981		1982		1983		1984		1985		1986	
SURVEYS AND MAPPING (78,000 ha)															
Upper Right Bank – 41,000 ha		—————													
Lower Right Bank – 37,000 ha			—————												
Layout and Design		—————													
REHABILITATION															
1R Canal Improvement – 65 Km		—	—	—	—										
2R Canal Enlargement – 67 Km			—	—	—										
Lateral Enlargement – 207 Km		—	—	—	—	—	—	—	—						
NEW CONSTRUCTION															
1R Canal Construction – 33 Km		—	—	—	—										
Lateral Construction – 103 Km		—	—	—	—										
Drainage System – 336 Km			—	—	—	—	—	—	—						
On-Farm Development – 71,000 ha Cult.			—	—	—	—	—	—	—	—	—	—	—		
LAND ACQUISITION – 500 Rai		—————													
EQUIPMENT PROCUREMENT BUILDINGS		—————													
LAND IN SERVICE – Ha Cumulative (Net)						4,000	12,000	30,000	50,000	66,000					

World Bank – 20498

**THAILAND
IRRIGATION XI
Implementation Schedule
Pattani**

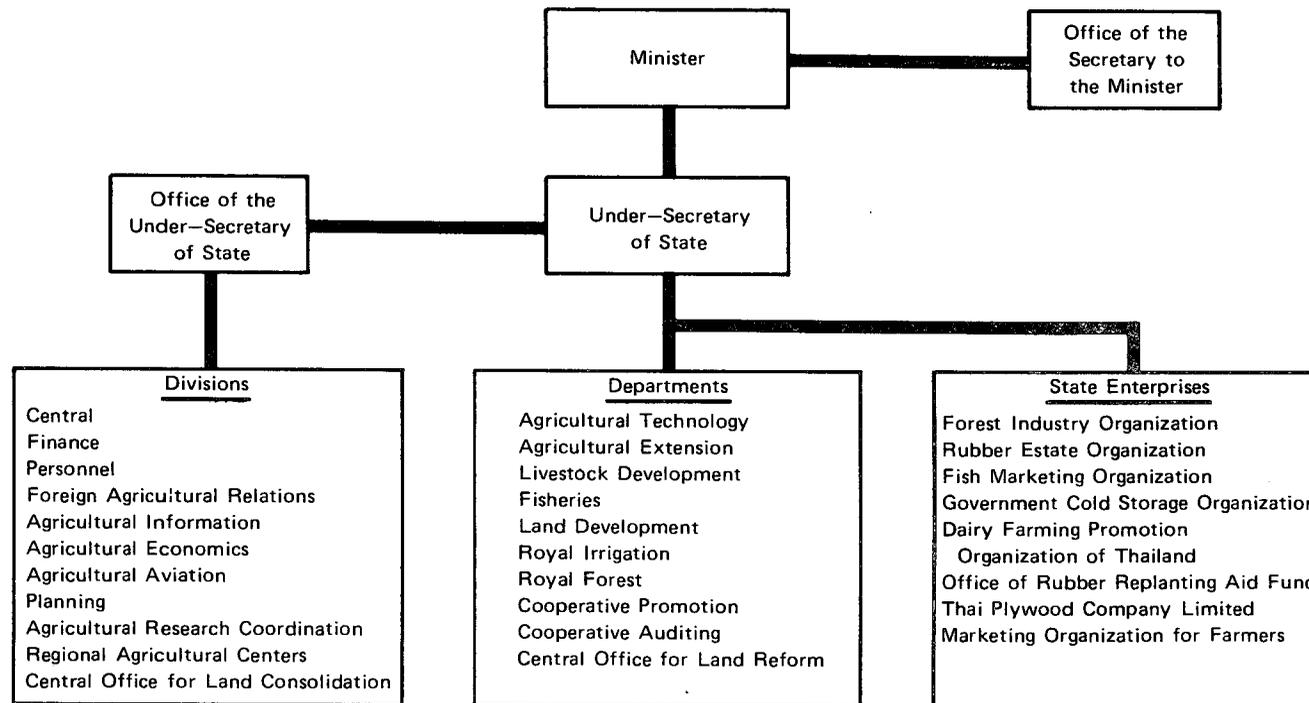
ITEM	Season		Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry
	Calendar Year		1980		1981		1982		1983		1984		1985	
SURVEYS AND MAPPING														
Right Main Canal and Diversion Area														
Center Main Canal Area			■											
Left Main Canal Area				■										
Land Classification Update			■	■										
FACILITY LAYOUT & DESIGN														
Right Main Canal - 26 Km			■	■										
RMC Laterals and Drains - 15,000 ha Net			■	■	■									
Center Main Canal				■	■									
CMC Laterals and Drains - 18,000 ha Net				■	■	■								
Left Main Canal					■	■								
LMC Laterals and Drains - 15,000 ha Net					■	■	■							
PROJECT (RMC) CONSTRUCTION														
Canal Rehabilitation - Km 1.5 to 24.5			■		■	■	■	■						
Canal Construction - Km 24.5 to 50.2					■	■	■	■						
Lateral Construction - 134 Km			■	■	■	■	■	■						
Drain Construction - 165 Km			■	■	■	■	■	■	■	■				
On-Farm Development - 16,000 ha Cult.					■	■	■	■	■	■	■	■	■	
LAND ACQUISITION														
Main Canal - 3100 Rai			■											
Laterals - 5750 Rai			■	■	■	■	■	■	■	■	■	■	■	■
Drains - 5250 Rai			■	■	■	■	■	■	■	■	■	■	■	■
EQUIPMENT PROCUREMENT														
BUILDINGS			■	■	■	■	■	■						
LAND IN SERVICE - Net Ha Cumulative							2,000		6,000		10,500		15,000	

**THAILAND
IRRIGATION XI
Royal Irrigation Department
Organization Chart**



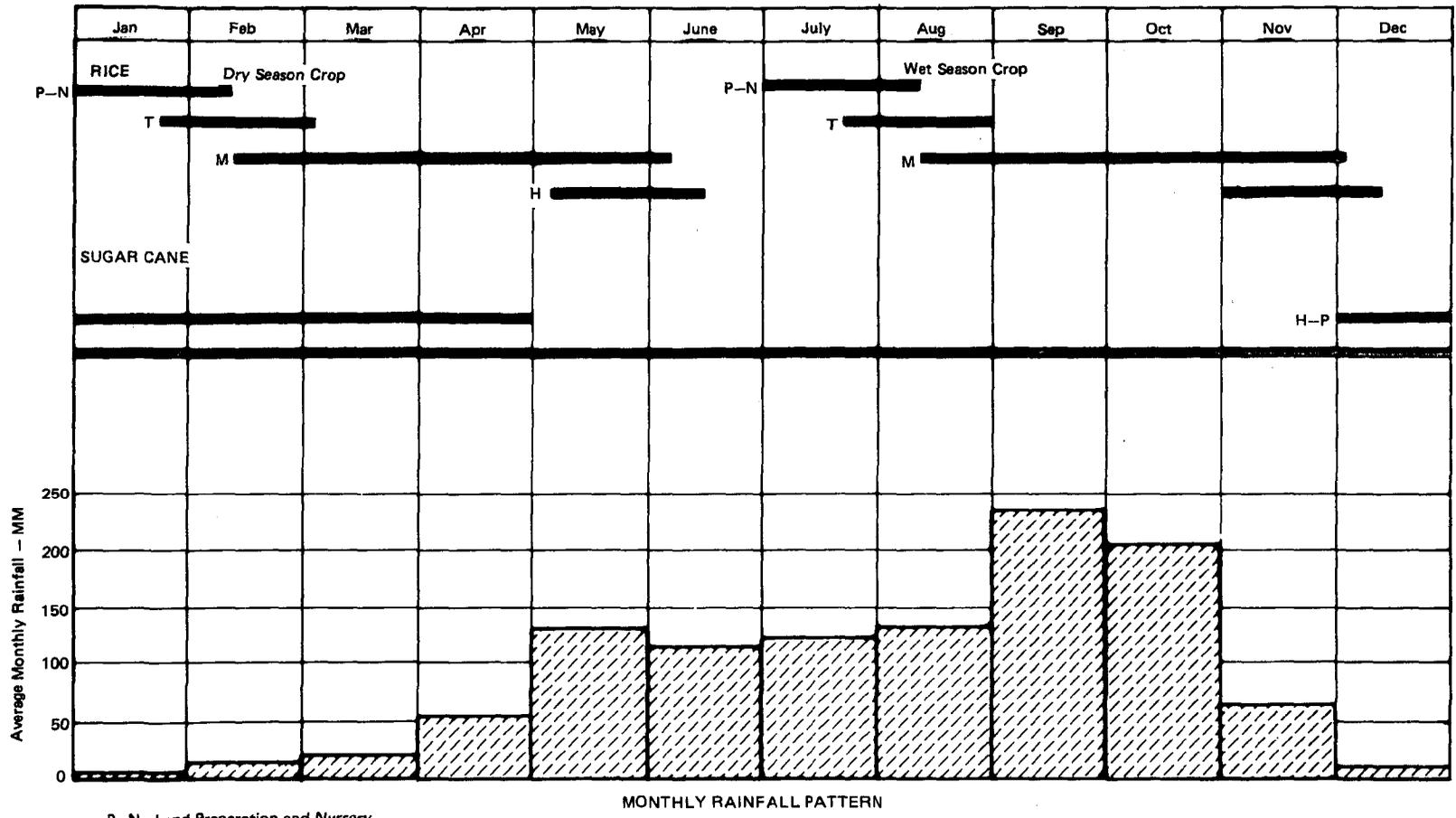
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**THAILAND
IRRIGATION XI
Ministry of Agriculture and Cooperatives
Organization Chart**



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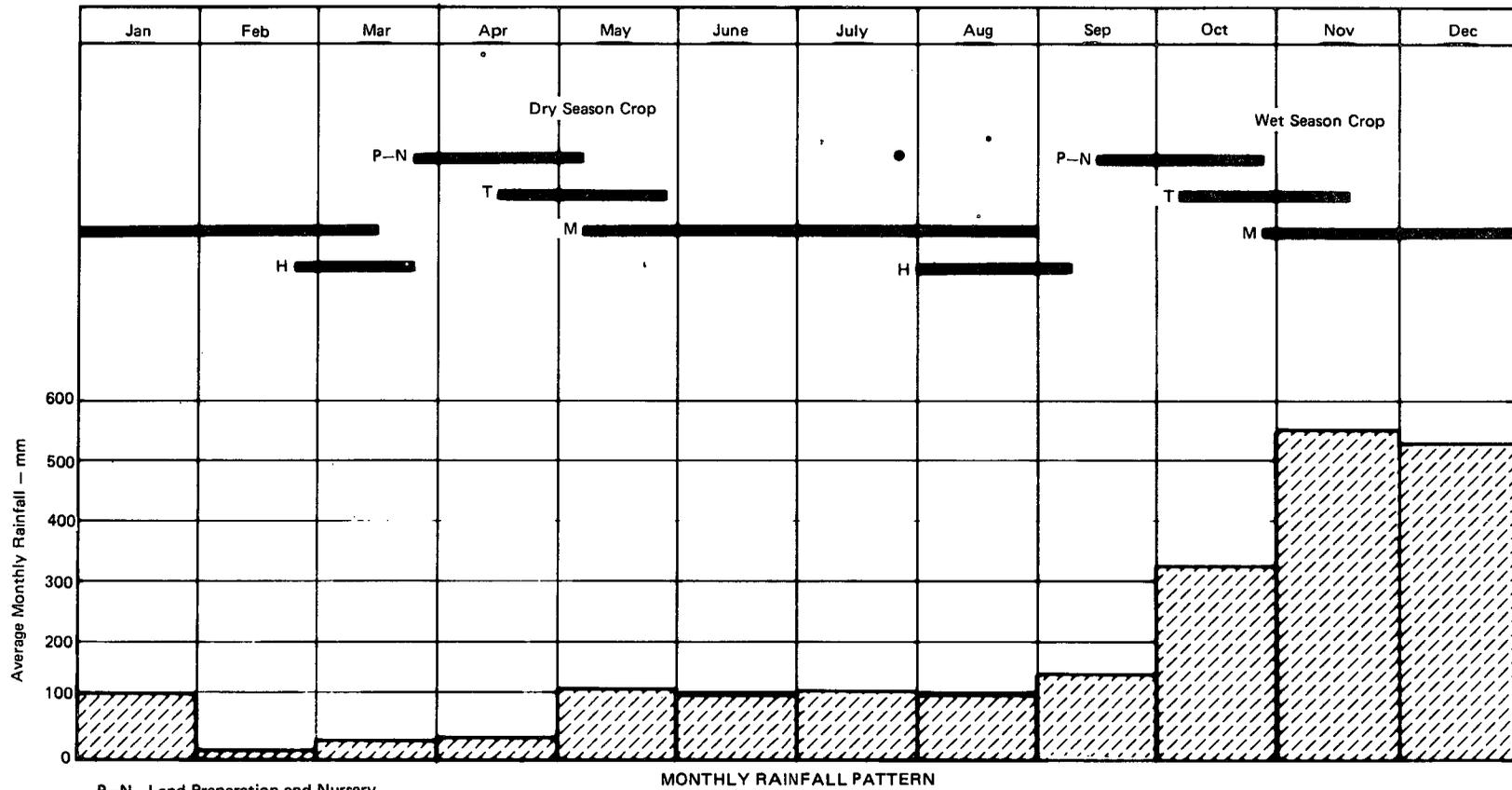
**THAILAND
IRRIGATION XI
Crop Calendar
Meklong**



P-N Land Preparation and Nursery
 T Transplanting
 M Management
 H Harvest
 H-P Staged Harvest and Planting Period

World Bank - 20499

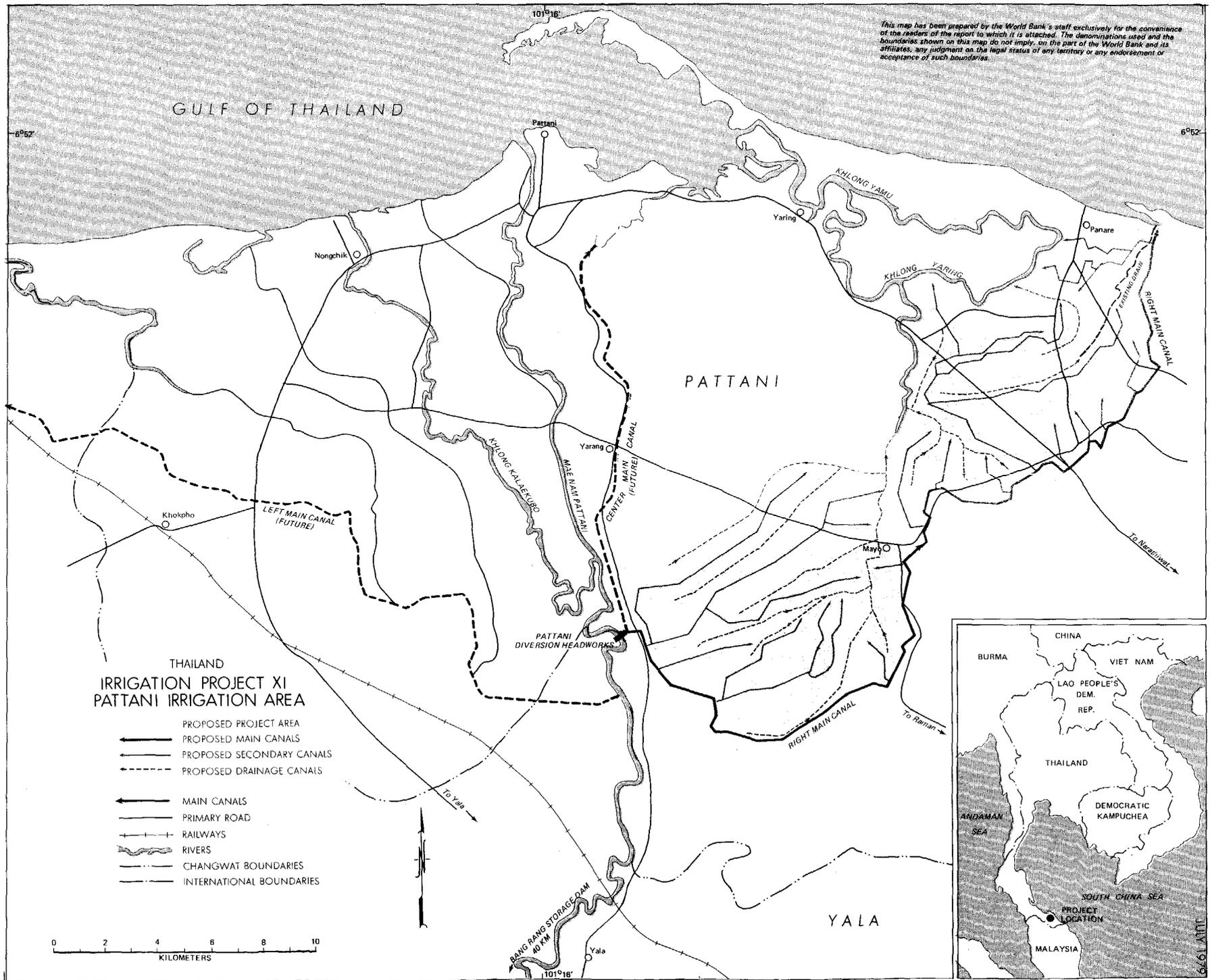
**THAILAND
IRRIGATION XI
Crop Calendar
Pattani**

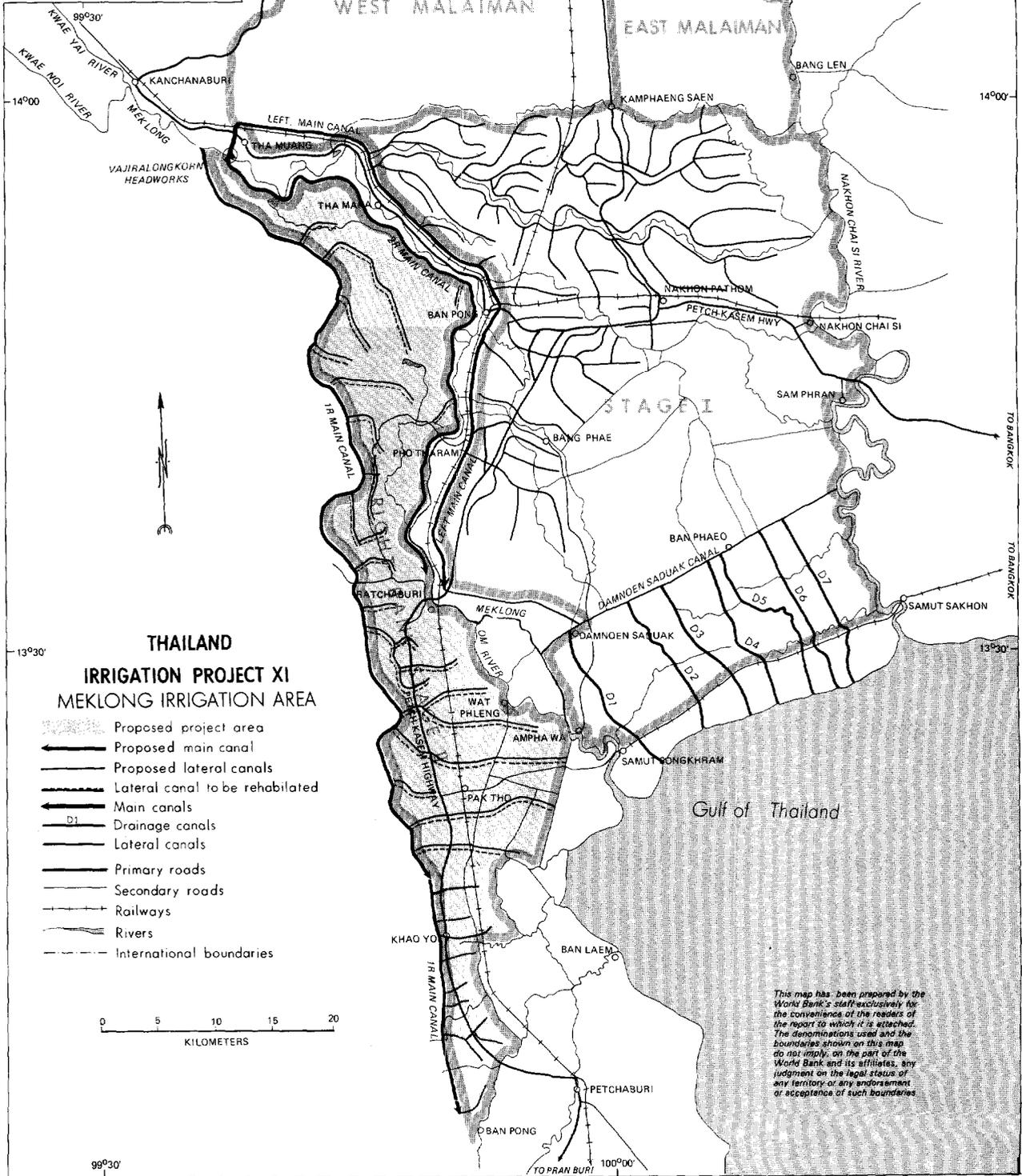
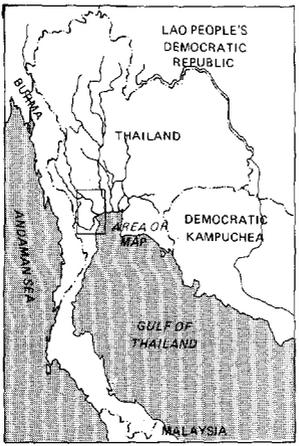


P-N Land Preparation and Nursery
 T Transplanting
 M Management
 H Harvest
 H=P Staged Harvest and Planting Period

World Bank - 20500

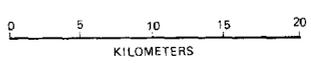
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THAILAND
IRRIGATION PROJECT XI
MEKLONG IRRIGATION AREA

- Proposed project area
- Proposed main canal
- Proposed lateral canals
- Lateral canal to be rehabilitated
- Main canals
- Drainage canals
- Lateral canals
- Primary roads
- Secondary roads
- Railways
- Rivers
- International boundaries



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