PROJECT PERFORMANCE AUDIT REPORT

THAILAND

IRRIGATION PROJECTS XI AND XII
(LOANS 1787-TH AND 2022-TH)

DECEMBER 21, 1990

Operations Evaluation Department

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CURRENCY EQUIVALENTS

Appraisal: US$ 1.00 = Baht 20.0
Currently: Floating at about US$ 1.00 = Baht 25.0

GLOSSARY OF ABBREVIATIONS AND ACRONYMS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Definition</th>
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<tbody>
<tr>
<td>CHO</td>
<td>Constant Head Orifice</td>
</tr>
<tr>
<td>FSL</td>
<td>Full Supply Level</td>
</tr>
<tr>
<td>Golongan</td>
<td>System of rotational irrigation used in Indonesia</td>
</tr>
<tr>
<td>HYV</td>
<td>High Yielding Variety</td>
</tr>
<tr>
<td>IRRI</td>
<td>International Rice Research Institute</td>
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<tr>
<td>JICA</td>
<td>Japanese Aid Agency</td>
</tr>
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<td>MOAC</td>
<td>Ministry of Agriculture and Cooperatives</td>
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<td>O&amp;M</td>
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<td>On-Farm Development</td>
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<td>Staff Appraisal Report</td>
</tr>
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<td>WASM</td>
<td>Water Allocation Scheduling and Monitoring System</td>
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FISCAL YEAR: October 1 - September 30
December 21, 1990

MEMORANDUM TO THE EXECUTIVE DIRECTORS AND THE PRESIDENT

SUBJECT: Project Performance Audit Report on Thailand Irrigation Projects XI and XII (Loans 1787-TH and 2022-TH)

Attached, for information, is a copy of a report entitled "Project Performance Audit Report on Thailand Irrigation Projects XI and XII (Loans 1787-TH and 2022-TH)" prepared by the Operations Evaluation Department.

Attachment
PROJECT PERFORMANCE AUDIT REPORT

THAILAND
IRRIGATION PROJECTS XI AND XII
(LOANS 1787-TH AND 2022-TH)

TABLE OF CONTENTS

Page No.

PREFACE .......................................................... i
BASIC DATA SHEETS ................................................ ii
EVALUATION SUMMARY ............................................... viii

PROJECT PERFORMANCE AUDIT

I. Introduction ..................................................... 1
II. Two Success Stories in Growing Rice ......................... 1
III. The Politics of Irrigation and Rice Production ............. 2
IV. The Early Years 1950-67 ...................................... 9
V. The Middle Years 1973-1980 .................................. 12
VI. The End of an Era 1980-90: The Mae Klong and Pattani .... 16
VII. Project Objectives, Definition and Design ................ 17
VIII. Project Implementation ...................................... 22
IX. Project Outcome .............................................. 24
X. Findings and Issues .......................................... 26
     Annex 1: An Alternative View ............................ 37

PROJECT COMPLETION REPORTS

IRRIGATION XI (Loan 1787-TH)

General ............................................................. 39
Background ........................................................ 39
Project Objectives .............................................. 40
Project Content ................................................ 40
Implementation ................................................... 41
Project Costs and Disbursements ............................... 44
Agricultural Production ....................................... 45
Project Impact ................................................... 47
Bank and Borrower Performance ............................... 48
Lessons Learned ................................................ 48

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IRRIGATION XII (Loan 2022-TH)

I. General ............................................ 51
II. Project Objectives and Content ........................ 51
III. Implementation ..................................... 52
IV. Project Costs and Disbursements ........................ 54
V. Agricultural Production ................................. 54
VI. Project Impact ....................................... 55
VII. Bank Performance .................................... 56
VIII. Lessons Learned ..................................... 56

ATTACHMENT

Comments from the Borrower .............................. 69

Maps

IBRD 22765 - Irrigation in the Northern and Central Regions as of 1985.
IBRD 22764 - Irrigation in the Northeastern Region as of 1985.
IBRD 22766 - Irrigation in the Southern Region as of 1985.
This is the report of the performance audit of Irrigation Projects XI and XII in Thailand. Irrigation XI was partially financed by a Bank loan of US$ 80.0 million and was approved by the Board on December 20, 1979. The Loan was closed on June 30, 1988 and US$ 25.6 million was cancelled. Irrigation XII was partially financed by a Bank loan of US$ 57.0 million and was approved by the Board on June 23, 1980. The Loan was closed on June 30, 1988 and US$ 22.6 million was cancelled.

The PPAR consists of the Project Performance Audit (PPA) prepared by the Operations Evaluation Department (OED) and the Project Completion Reports (PCR) prepared by the Government, in the case of the Pattani Scheme, and by consultants on behalf of the Government in the case of the Mae Klong Schemes. The PCRs attached to this audit are summaries, prepared by World Bank staff, of the originals as the originals are too lengthy to reproduce. Copies of the originals can be obtained on request either from the Region or OED.

The PPA is based on the attached PCRs, the Staff Appraisal and President's Reports, the loan documents, the transcripts of the Executive Directors' meetings at which the projects were considered, on a review of project files and on discussions with Bank staff. An OED mission visited Thailand in February 1990 to discuss the effectiveness of the Bank's assistance and to make field visits to the completed projects.

The PCRs provide an adequate account and assessment of the project experiences.

Following standard OED procedures, copies of the draft PPAR were sent to the Government and the Borrower. The comments received from the Royal Irrigation Department are reproduced as an Attachment to the PPAR.
# Project Performance Audit Report

## Thailand

### Irrigation Projects XI and XII

(Loans 1787-TH and 2022-TH)

## Basic Data Sheet

### Key Project Data

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<th>Item</th>
<th>Appraisal Expectation (US$ million)</th>
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<th>Actual as % of Estimate</th>
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(US$ millions)

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### Staff Inputs

(Staff weeks)

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---

### Other Project Data

**Borrower:** Kingdom of Thailand  
**Executing Agencies:** Royal Irrigation Department  
**Follow-on Projects:** Irrigation XII  
(LOAN 2022-TH)
# PROJECT PERFORMANCE AUDIT REPORT

THAILAND
IRRIGATION PROJECTS XI AND XII
(LOANS 1787-TH AND 2022-TH)

**BASIC DATA SHEET**

## Key Project Data

<table>
<thead>
<tr>
<th>Item</th>
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<td>Economic Rate of Return %</td>
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## Cumulative Estimated and Actual Disbursements (US$ millions)

<table>
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<th>FY84</th>
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### Project Dates

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### Staff Inputs
*(staff weeks)*

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### Other Project Data

**Borrower:** Kingdom of Thailand

**Executing Agencies:** Royal Irrigation Department

**Follow-on Projects:** None
EVALUATION SUMMARY

1. Starting in 1950 and continuing until 1981, the World Bank has made 16 separate lending operations in support of irrigation and water control in Thailand. This is the audit report of the last two projects that were undertaken in 1980 and 1981. Much has happened in the agriculture sector and water subsector in thirty years of active lending and a great deal has transpired in the nine years since the last project agreement was signed. On balance the experience has probably been a successful one, though not always for reasons anticipated. The intention here is to pull together and summarize that experience, not only to provide the necessary context for understanding the audit of the last two operations but, to serve as a repository for lessons learned in retrospect. (PPAR Paras. 1-2)

2. In Thailand, government policies affecting rice production have been extremely complicated. The tax and export policies of the Ministry of Commerce have tended to discourage surplus rice production and exports from all rice farmers while the irrigation investment and cost recovery policies of the Ministry of Agriculture's (MOAC) Royal Irrigation Department (RID) have tended to promote commercial production from a relatively select group of rice farmers in favorable geographic areas. The net impact of the contradictory Thai policies has been successful in a macro economic sense but, as should be expected from diametrically opposed policies unevenly distributed over time, space and income groups, both the benefits and costs can appear in unexpected places.

3. Thai farmers (pre 1982) received a much lower price for their production than would have been the case in a free market. Urban dwellers benefitted by receiving an important consumer good at prices lower than a free market would provide. As a result there has been a huge transfer of resources in Thailand from commercial rice farmers to urban dwellers.

4. On the investment and technology side, the explicit policy was to alleviate rural poverty by providing public infrastructure in the form of roads, electric power and irrigation. Rural roads and electrification programs have proceeded well and the bulk of the population now have access to these services. The attempt to do the same thing with irrigation and water control has been less successful for reasons of geography and the uneven distribution of land and water resources. This, however, was not for lack of trying. The thrust of the government has always been to give free water to as many farmers as possible and this was the popular RID
objective - develop large, medium and small scale schemes to the point where most farmers have control over water and most benefit from the public irrigation subsidy.

5. At the macro economic level the Thai policies have been generally successful. Thailand is the world's leading exporter of rice with a thirty to forty percent share of the international market. At the micro economic level the irrigation investment policy has led to a relatively small group of irrigated farms receiving the benefits of free dry season water. Within the individual irrigation schemes the policy of free water has led to destructive rent-seeking behavior. Extensive farmer alteration of the physical infrastructure has taken place. (PPAR Paras. 5-15)

The Early Years 1950-67

6. In the seventeen years 1950-67 six water control projects were partially financed by the Bank. No further loans were made in the period 1967-1972. The first twenty years of Bank-supported projects began to come on stream, providing an improved but by no means "high tech" irrigation technology. The impact of all this began in the 1960s below the Chai Nat diversion dam in the Chao Phya plain. The water from Sirikit dam had become available in 1972 and, together with the water from the earlier completed Bhumiphol dam (1965), was having a large impact on dry season irrigation. A partial picture of what was happening at that time can be obtained from the first audit report produced by OED in 1980:

In 1972, the area of dry-season cropping was about 107,000 ha. compared with a potential of about 450,000 ha. which could be supplied with water from Bhumiphol and Sirikit reservoirs. However, since 1972 the dry-season cropped area has grown rapidly and reached about 400,000 ha. in 1978. This was largely due to a sharp increase in paddy prices which rose from US$45 per ton in 1972 to US$115 per ton in 1978, providing strong incentives to farmers. About 200,000 ha. of the dry-season cropped area is now irrigated by low-lift pumps in the Southern Chao Phya plain in areas formerly devoted to a single wet-season crop of flood-dependent rice. In these areas farmers have given up wet-season cultivation in favor of dry-season cropping. The remaining 200,000 ha. are double cropped, of which 150,000 ha. are irrigated by gravity and 50,000 ha. by low-lift pumps.

7. When large amounts of dry season water became available in the Chao Phya Basin in the mid 60s and early 70s, farmers began to switch to dry-season rice cropping slowly at first and then rapidly after the Sirikit flows became available in 1972. The years 1968-72 were years of low domestic rice prices, and the incentive to grow more rice was not great even with the Bhumiphol dry-season flows commencing in the mid 1960s. The switch accelerated after the relatively high price year of 1973 in which nominal domestic prices increased by 44 percent and in real terms increased by 25 percent.

8. The other important development taking place at the time was the indigenous development and deployment of the axial-flow low-lift pump. Of the 400,000 ha. of dry-season cropping undertaken in the Chao Phya Basin by
1978, about 250,000 was achieved with the use of locally manufactured low-lift pumps delivering the dry season water to fields from canals, drains, borrow pits, road-side ditches and ponds. In the absence of tertiary delivery systems, the local farmers found an "appropriate" technology to help them make use of the water that was spread widely over the countryside by the primary and secondary canal and drainage system that had been put into place.

9. Domestic production of these simple and inexpensive pumps commenced in 1957. By 1967 it was estimated that there were 80,000 in operation, mostly in the Central Plain. By 1975, the number had increased to 176,000. In 1983 there were estimated to be over 600,000 in operation. The extraordinary fact is that this technological innovation has received hardly any formal recognition by irrigation engineers in Thailand. It is relegated to the farm mechanization profession. The fact that Thai farmers had, in the late 1960s, partially solved the problem of how to deliver water from a system of primary and secondary canals and drains if the price of rice was attractive has escaped those interested in modern irrigation technology. The possibility that canal (and drain) delivery systems might be consciously designed to incorporate this technology was not noted.

10. With the improved control of river flows in the most important rice growing basin in the country, the semi-controlled inundation delivery system was judged to be in need of improvement and a "ditches and dikes" program in the Chao Phya was financed in 1963. This project was designed to provide the missing tertiary canal systems in the 600,000 ha. North Chao Phya Plain. This, however, was to be a low cost "extensive" form of on-farm development in which standards of water control were low. The latest available irrigation technologies were not yet being recommended. (PPAR Paras. 16-21) 1/

The Middle Years 1973-80

11. In the first seventeen years of Bank lending, six projects were undertaken. In the seven-year period 1973-1980, eight more projects were undertaken. Development of water resources, and the Bank's participation in that development, was accelerating. The emphasis was on finishing the work begun by approaching seriously the Japanese level of technological sophistication. If only the water control was dependable and precise enough and the fields were reshaped and leveled enough, the Thai farmer would employ other inputs to finally achieve the sort of "high-tech" operation that was associated with four to five ton per ha. yields.

12. Given the World Bank's international rice price projections and plausible intensity and yield figures, all of these projects were economically feasible. It was also assumed that the high economic prices would be reflected in higher farm-gate prices and that farmers net crop income would at least double and possibly triple.

1/ For an alternative view of these historical developments from the Region see Annex 1.
13. In early 1976 the first comprehensive review of the irrigation subsector was prepared. This was necessitated largely by the accelerating lending program and the severe difficulties encountered with implementation. It is an illuminating document in that it gives a good picture of the nature of the thinking that was going on at that time. Rice production became a simple function of domestic consumption and exports. Consumption became a function of population. Export levels were then determined either by assuming a constant share of Bank projections of international rice trade or a constant level of exports.

14. The major flaw in the underlying analysis was the estimate of future domestic consumption. Per capita rice consumption was projected to increase from 165 kg in 1976 to 170 kg in 1990 requiring an extra three million tons by 1990 for consumption. In fact the per capita consumption has steadily declined since the early 1970s reaching a level of 138 kg in 1982/83. This decline was already in evidence by 1976, with a peak consumption level of 182 kg in 1970/71. The entire consumption and export demand picture for rice, which drove the resulting irrigation investment program, received one and a half pages of text and one table in the entire document. A declining consumption rate would have raised serious questions about the urgency of the irrigation investment program. In a twenty-six page annex on agriculture there was no discussion of prices or government policy affecting prices.

15. The 1976 Review did pick up the fact that even though the Northern Chao Phya Basin had received most of the irrigation investments for dry-season cropping, the big increases in dry season production had mostly (over 60%) come from the Southern Plain where farmers, receiving dry season water from Sirikit and Bhumiphol Dams, had abandoned low-yielding wet-season rice subject to flood damage to irrigate high yielding dry-season rice with water pumped from improved drainage canals. The early Bank-supported investments in dry season storage were paying off, but not quite the way the engineers had anticipated.

16. The 1980 OED Audit Report of the Sirikit Dam Project and the First Chao Phya Improvement Project noted the effect of the 1973 farm gate price increases on dry season cropping. Of more concern to the 1980 audit was the basin-wide shortage of dry-season water in the Chao Phya. There is not even enough water to obtain full benefits from the last two Bank-assisted projects: Phitsanulok (Loan 1149) and Chao Phya II (Loan 1468).

Why did the Bank approve two loans (Loan 1149 of 1975 and Loan 1468 of 1977) for irrigation projects which would push water demand beyond the overall basin's water availability ceiling...?

The audit provides a partial explanation:

The Bank's decision to support the Chao Phya I project was made before the spontaneous expansion of dry season cropping and its implications became apparent. The decision on Phitsanulok was made when some information was already suggesting that water supply might not be fully adequate for the project. However, both the cropping
trend and its implications were fully apparent when the Chao Phya II project was appraised in 1976.

For the case of Chao Phya II Project, undertaken in 1977, no satisfactory explanation was ever given. It was the last Bank-supported expansion scheme to be undertaken in the Chao Phya Basin. (PPAR Paras. 22-31) 2/

The End of an Era 1980-90: The Mae Klong and Pattani

17. By 1978, efforts were being made to reduce the size of the dry-season planting in the Chao Phya Basin to match the water available. Too large an area was served by irrigation infrastructure though critics were quick to point out that it all needed "modernizing" if the full benefits of the investment were ever to be realized. In the 1980s attention then turned to the water-surplus Mae Klong Basin which had begun the main diversion dam in 1965 and the first upstream storage dam in 1974. A second hydro and storage dam was undertaken in 1980, the Khao Lam Project. The pattern was similar to that followed in the Chao Phya Basin: first a diversion dam and canal system for spreading wet season flows, followed by upstream storage to firm up wet season flows and provide dry season water, followed by more upstream storage. The stage was then set for the development of the Mae Klong in a manner that would avoid the shortcomings experienced in the Chao Phya. It was also time to follow up on the Pattani hydro investment of 1977 in the extreme south of the country where the storage provided for generating electricity could also be used for irrigation.

Project Objectives, Definition and Design

18. Both the Mae Klong and Pattani projects were on-going operations whose overall dimensions had been decided many years earlier. In most cases a good deal of engineering and construction had already been done. The task was to rehabilitate, upgrade and expand - complete what had been started and repair what had not been maintained. Irrigation XI comprised the Mae Klong Right Bank Scheme and the Pattani Right Bank Scheme, while Irrigation XII was for the Mae Klong Left Bank scheme only. In terms of technology, the idea was to provide a form of on-farm development (OFD) for 66,000 ha. on the Mae Klong Right Bank, 27,000 ha. on the Mae Klong Left Bank, and 15,000 ha. on the Pattani Right Bank, a total of 108,000 ha. The OFD proposed would give most plots direct access to a tertiary canal which commanded the surrounding land. Intensive on-farm development which involved land leveling and boundary realignment to effect efficient grid patterns of the Japanese model was too costly to consider. The plots would have access to supplemental wet-season water and adequate dry-season water to allow improved wet season rice yields and a high yielding second crop in the dry season.

19. The basic design incorporated open canal gravity flow technologies with upstream control structures that assumed that the operators of the system could match the demand for water with the supply by

2/ For an alternative view of this historical development see Annex 1.
manipulating the various control structures at the primary, secondary and
tertiary level. A public, salaried canal bureaucracy would integrate the
feedback from the farm fields with the supply of water and the needed gate
settings. This process was to be computer assisted and the program and its
use was given the name of Water Allocation Scheduling and Monitoring
System, the WASM System. It was a simplified version of the system
developed by the Dutch in colonial Indonesia before the age of the
computer.

20. In terms of policy initiatives, the Bank was to push for a
reorganization of RID that would emphasize operation and maintenance rather
than construction and the imposition of water user charges that would
promote the efficient use of water and serve an equity objective since only
a relatively fortunate few of the rice farmers of the country were
receiving supplemental wet season water and an even smaller group were
receiving dry season water.

21. The key economic and financial assumption was that farm-gate
prices would be allowed to rise just as world market prices were predicted
to. Thus, in the SAR for Irrigation XI financial farm-gate prices were
assumed to increase in real terms by 45 percent over the period 1980-90 and
remain at that increased level thereafter. A year later with Irrigation
XII the assumed growth of the same factor over the period 1981-90 was a
more modest, but still a substantial 18 percent. These assumptions,
together with the cropping intensity and yield assumptions led to
approximately a doubling of net farm income for Irrigation XI and a
doubling of net small-farm (2 ha) income and a tripling of large (5 ha) net
farm income with Irrigation XII. Thus, both the economic and the financial
analyses were consistent. (PPAR Paras. 33-45)

Project Implementation

22. In the Mae Klong Right and Left Bank projects, most of the
primary and secondary rehabilitation and extension works were completed.
However, of the 66,000 ha service area of the Right Bank, only 37,700 ha of
the tertiaries and on-farm development (OFD) took place. On the Left Bank,
only 22,000 ha of the original 27,000 ha service area was covered with the
OFD work. Overall for the Mae Klong, only 62 percent of the tertiary
system was put into place by the time of loan closing in late 1988. The
problem here was that about 38 percent of the farmers either did not want
or could not agree on the high tech tertiary development that required land
without compensation. 3/

23. In the Pattani scheme the problem was more serious: the farmers
initially did not want any on-farm development. Only 4,300 ha of a planned
15,000 ha of OFD was completed some nine years after the loan was signed
and OFD development continues well after loan closing. The main and
secondary canals were delayed also because of contract administration
problems.

3/ For a more positive view of this development see paragraph 6 of
Annex 1.
24. After the fifth supervision mission of Irrigation XII in 1985 the problem of actually making the system work as designed was beginning to be apparent. In the Mae Klong, it was assumed that the lack of cooperation of the farmers stemmed from their lack of understanding of how the OFD would benefit them. An intensive program of farmer training was subsequently undertaken together with the WASM initiative. The consultants made an all out effort to address the problem of farmer resistance and mobile teams of educators were fielded with audio-visual presentations designed to explain the benefits of the project and allay fears. In the Pattani scheme things were more serious. There was a fundamental lack of trust between the engineers and the farmer beneficiaries. Accepting tertiary development meant giving up title to scarce land without compensation to the government before getting the civil works. To do this requires not only the belief that the civil works are beneficial but that they will in fact be put in place. To build trust requires more time and effort than building canals. This is being accomplished at Pattani, but at a pace much slower than envisioned in the project proposal.

25. Progress in the area of the much sought after RID administrative reform was monitored early in the supervision cycle of Irrigation XII where an action plan and attention to implementation of the plan was a specific covenant in the Loan Agreement. In April 1982 an RID Action Plan was submitted to the Bank. There was a flurry of activity in the Bank to follow up on the RID initiative and a public administration expert accompanied the second supervision mission. In their report of January 1983 it was stated that a separate working paper on public administration would be issued. There is no copy on file. The issue was apparently given less attention than problem of implementation of the OFD component.

26. The other big institutional objective was to begin to collect irrigation user charges. This was a covenant under the Irrigation XI Loan Agreement. The enabling legislation had been drafted and approved by the Cabinet prior to negotiations. Everything hinged on the passing of the proposed law by the Thai legislature. Since this never happened, the detailed agreements for implementation were never triggered. A free water policy continues to be the official position of the Thai government. (PPAR Paras. 46-52)

**Project Outcome**

27. In the end, $25.6 million of the $80.0 million Irrigation XI was cancelled, while $22.6 million of the $57.0 million Irrigation XII was cancelled. The retrospective rates of return of the two Mae Klong projects are now in the 7-8 percent range while that of the Pattani scheme is around 5 percent. This assumes that another 7,000 ha. of the Mae Klong Right Bank OFD work will eventually be done after loan closing and another 9,000 ha. of the Pattani OFD work will be accomplished. If one considers the heavy pre-project sunk costs excluded from the economic analyses then the economics of these high tech schemes providing wet and dry-season water are not very impressive. Not only is the price of rice low at the farm gate, it is now so low in the world market that even with the assumptions concerning yields and cropping intensities actually taking place, the
economics of such schemes no longer make a persuasive case for going forward.

28. Added to this sobering development is the evidence that the high tech elements of the system that have been implemented are not at all being used as the engineers intended. Few of the key structures in the Mae Klong and the Pattani have been calibrated - so measuring the major flows is impossible even if it were desired. Despite the assertion in the PCRs that the WASM system was a success and should be implemented throughout the country, it was quite clear to the Audit that it was not being used at all to manage the system either in the Mae Klong, where it was first developed, or in the Pattani, where it was to be introduced. Most of the key structures are not calibrated and many of the tertiary offtakes have been damaged by farmers, especially in the Mae Klong. In addition, RID is having great difficulty in recruiting, training and keeping gate operators who could operate the system even if it were operable. The rapid private sector industrial development of the country is attracting most of the numerate graduates of technical schools. Finally, rent-seeking behavior on the part of farmers is clearly present. Visible proof of this, beyond the damaged control structures, is the numerous permanent pipe installations that regularly pierce the primary and secondary canal banks to take water on demand either by syphon or by pumping. (PPAR Paras. 53-56)

Findings and Issues

The Macro Economic Picture

29. The Bank got involved in supporting irrigated rice production in Thailand during a period in which world market prices for rice were high relative to Thai production costs and the revenues from the effective export tax on rice were important for the public finances of the country. When cost reducing irrigation infrastructure providing supplemental wet-season and dry-season water came on the scene in the mid 1960s the high rice tax and resulting low domestic price for rice militated against the rapid intensification expected. More appropriate price incentives were introduced from 1973 on, during a time of unprecedented high world market prices. Paddy production, led by supplemental wet-season irrigation production expanded steadily.

30. On the export scene two important factors were operating. Thai population growth was slowing to 2.0 percent per year, and the per capita consumption of rice was declining at roughly 2.0 percent per year. Domestic rice consumption remained about constant over the ten year period and the entire increment in output had to be exported. By 1982, when world rice prices collapsed, Thai exports were about four times their 1972 levels. The tax wedge between world and domestic prices had shrunk to less than ten percent and the Ministry of Commerce had much less flexibility in manipulating domestic and world prices. By 1989, Thai rice exports accounted for 41 percent of the international market and Thailand has become the main player in that market, albeit at price levels about 50 percent lower in real terms than pre 1982 levels. The high cost producers such as the U.S. are slowly leaving the market. Extremely low cost producers such as Viet Nam are now entering the market.
Underlying Structural Changes

31. Beyond the issues of farm-gate prices and free canal water, developed above, it is possible to identify a number of important structural changes that were taking place in the Thai economy and society that were to have a great impact on how irrigation schemes were to perform. These come under the headings (i) declining relative importance of rice, (ii) part time farming, (iii) public sector skill shortages, and (iv) urban and industrial competition for water. (PPAR Paras. 59-63)

Modes of Thinking About Irrigation

32. The dominant concept of irrigation in Thailand has been and remains that of open canals delivering free water to the root zones of plants by gravity. The means for doing this was through a large canal bureaucracy dedicated to matching the demand for water with the supply by frequent setting of gates and flow measuring devices. When demand exceeds supply the same bureaucracy then applies a rationing system designed to achieve an equitable distribution of the scarce water to the tens of thousands of poor farmers who would otherwise be without water. This simple and powerful paradigm has an inordinate appeal to engineers, civil servants and politicians.

33. A great deal of evidence exists to support the contention that almost none of the constant head orifice structures have ever been used to measure flows as part of an overall water allocation plan. Yet, in the case of the Pattani scheme, where the Right Bank experience has been little short of disastrous, the Left Bank design is proceeding with the constant head orifice as the main tertiary control structure. The engineers explain this apparently irrational action on the grounds that "someday" it may be possible and desirable to measure water flows and the facilities to do so will then be in place. In the mean time; the flow measuring devices, which have not been broken by the farmers, are merely used as costly gates in the "on" or "off" mode; farmers perforate the canal banks with pipes for water on demand; and inexperienced gate operators respond to farmer pressures. Reality bears little resemblance to the paradigm and a form of populist anarchy reigns.

34. For those who accept the local and international empirical evidence that the systems are, for very good reasons, operating under a regime substantially different from design intentions; many interesting possibilities present themselves. The most obvious thing to do is to examine how the existing systems actually operate and how the farmers interact with the system and its operators. In a country as large and varied as Thailand with a strong commercial ethic there are bound to be numerous "successes" in which public systems have been modified by the farmers to actually produce the services some farmers want and need. The pilot sugar technology in the Mae Klong is only one example. A careful study of the wide-spread on-demand pumping from canals, its extent, and the means of distributing the water once it is removed would be another obvious area to investigate. It serves no purpose to ignore this reality and it may be something that should be encouraged. A study of farmer damage to control structures is also an obvious need. It serves no useful purpose to
ignore this rent-seeking reality since it creates much of the maintenance problem in the country.

35. Engineers with successful experience in the design and operation of modern, fully-gated, hydraulically stable irrigation systems tend to see the solution of the "Thai irrigation problem" as one of modernization and increasing sophistication and complexity to make the systems deliver their intended services. Engineers with experience with large public systems in areas with high rainfall wet seasons, like much of monsoon Asia and Central and Southern Thailand, tend to see the solution as the "structured" one of decreasing hydraulic sophistication and increasing concern for control and protection of the infrastructure from farmer damage and intervention. The latter group have clearly gone beyond the irrigation paradigm. 4/

36. Economists point out that any system paid for by user charges and under the control of the farmers tends to perform well. The economists push the notion of water user charges and financially self-sufficient parastatal operators so that farmers get water by paying what it is worth rather than trying to control the bureaucracy that allocates water or modifying the physical infrastructure. A pricing system harmonizes interests and sets unambiguous rules. For economists part of the solution to the "Thai irrigation problem" is to make the RID budget dependent on water user charge revenues, just as the state power company and the state railways are largely dependent on revenues from users. Experience in the Philippines has shown the dramatic change in attitudes of the irrigation bureaucracy when the incentives facing the management and farmers shift to quasi commercial standards.

37. Still another group of professionals see a different route to addressing the problem. These are the rural sociologists that approach the operation of an irrigation scheme not as a complex problem of the hydraulics of open channel flow. Rather they see it as an exercise in cooperative group dynamics in which social engineering is at least as important as hydraulics. Rent-seeking behavior can be controlled if the right social institutions can be brought to bear on the problem. They point to the successful irrigation associations in Bali, Taiwan and Japan as proof that rent-seeking behavior need not break out in public irrigation schemes. They usually embrace the notion of the economists that the financial participation of the farmer in the construction and operation of the scheme is an essential ingredient of success. Engineers have no quarrel with the position of the sociologists concerning water user groups and generally wish them well, occasionally citing the failure to form effective groups as being the reason their infrastructure is not being used as designed. The sociologists are also the people most qualified to address the effect of part-time farming on the use of public irrigation systems. Neither the economists nor the engineers are equipped to address these sorts of questions. (PPAR Paras. 64-73)

4/ See the Region's qualification of this statement in footnote 57 on page 30 of the PPAR.
Conclusions

38. In retrospect, RID's and the Bank's early engineering approach to irrigation development could be characterized as an unconscious variant of the "structured" approach to system design. First, spread the water with diversion structures and a primary and secondary canal system. Gated tertiaries and on-farm development would not be included. Then, provide dry season storage to firm up wet season flows and provide for some dry-season cropping. If this had been combined with an attractive farm-gate price for rice in the mid 1960s by a sympathetic Ministry of Commerce, then success could have been declared as the rice would certainly have been forthcoming, given the reservoir storage, the low-lift pump technology and the supply elasticities.

39. In the Mae Klong the problem of too much investment for the water available was avoided. However, the gated technology chosen in the final projects was not, in retrospect, appropriate for the relatively high wet-season rainfall conditions nor for the rent-seeking environment created by a free water policy. Going for high-command, manually operated, extensively-gated systems was, in retrospect, a questionable decision since this form of modernization and upgrading did not take account of what was actually happening and what could work in the Thai context. A much less costly extension of the "spreading" infrastructure without the gates and without the high canals on fill would have extended irrigation potential (similar to that already incorporated on twenty-five percent of the pre project area) to the bulk of the farm population without the uneconomic capital costs.

40. The major contribution of Thai farmers to public tropical irrigation systems is their demonstrated willingness to pump water the final meter or so to their crops. A privately owned final delivery system incorporated into a public, "structured", largely gateless canal system with FSL at or below ground level is an intriguing concept. It fits with the, by now, indisputable Thai policy of free canal water and a large centralized canal bureaucracy. It fits the wet season rainfall conditions of the south and the central plain and it squares with what the farmers are actually doing. If actual experience could ever overcome the powerful attraction of the irrigation paradigm, it is quite likely that Thai engineers could then encourage the development of an appropriately Thai irrigation technology that would not have to be patterned after what worked for special reasons in Japan, California, North Africa or colonial Indonesia. The elements of such a technology are already emerging. It takes official recognition of what already exists to make these initiatives technically respectable. The rest of rice-growing tropical Asia would then have a model to look towards that might help them with their own divergences between design and reality. 5/

5/ The Region takes strong exception with this view. See footnote 60 on page 33 of the PPAR.
Caveats

41. There are two major concerns the Audit has with the line of reasoning set forth above. The first is the danger of simplification and overstatement in order to make a point. The fact that there are probably over a million low-lift pumps operating in the country today and that Thai farmers are willing to use this technology in conjunction with public irrigation schemes to give them the flexibility they need to produce a range of crops is an attractive development for those interested in agricultural production and crop diversification. Seizing on this possibility as a panacea is the danger. There is no magic in this development. It already exists where it makes sense and it only needs to be officially recognized by the engineering profession and documented. Most public irrigation schemes in Thailand have already been modified by influential and well-located farmers to give them what they need. Some of these modifications, principally the permanent pipe installations in the canal banks, clearly require the active or passive cooperation of the canal bureaucracy.

42. The second concern is the equity issue. One of the most attractive features of the official engineering designs is that every farmer in the command area, in theory, gets his fair share of the available water. The fact that, in reality, upstream users and those close to the primary and secondary canals get much more than their fair share at the right time is indisputable. The Golongan system of rotation has not worked in Thailand any better than it has in Indonesia. If one accepts the inherent and inescapable inequity of the present system of populist anarchy, then the jump to a demand-oriented first-pump-first-served system that is, even in theory, inequitable is less difficult to contemplate. It is, in the Audit's opinion, likely that accepting this inequity will allow the designers to produce a system that is both more efficient and less inequitable than that which exists at present. This is something that would have to be studied carefully. For those who insist that the existing systems can be made to work according to the original equitable designs, the contemplation of something that is admittedly inequitable at the outset is a step backward. The problem with the theoretical position is that all the empirical evidence is against it. It then becomes a hopeful assertion rather than a realistic assessment of what is possible.

43. In most countries the pressure of events in the form of food shortages or public sector budget constraints eventually forces irrigation system designers to modify design assumptions to incorporate past experience and current research findings. In Thailand neither of these forces is operating and the only signal that something may be wrong is the low economic returns to large scale irrigation investments including the two under audit. This by itself is unlikely to effect any changes. The only near-term inescapable physical reality in Thailand that cannot be ignored is the increasing scarcity of surface water resources for agriculture and urban industrial and domestic consumers. Even this pressure will not necessarily generate a real need to incorporate actual operational experience into the design of future irrigation system investments as long as inter-basin transfers are a technical possibility. (PPAR Paras. 74-82)
PROJECT PERFORMANCE AUDIT REPORT

THAILAND
IRRIGATION PROJECTS XI AND XII
(LOANS 1787-TH AND 2022-TH)

I. Introduction

1. Starting in 1950 and continuing until 1981, the World Bank has made 16 separate lending operations in support of irrigation and water control in Thailand. This is the audit report of the last two projects that were undertaken in 1980 and 1981. Much has happened in the agriculture sector and water subsector in thirty years of active lending and a great deal has transpired in the nine years since the last project agreement was signed. On balance the experience has probably been a successful one, though not always for reasons anticipated. The intention here is to pull together and summarize that experience, not only to provide the necessary context for understanding the audit of the last two operations but, to serve as a repository for lessons learned in retrospect.

2. The above considerations lead to a format that is heavily loaded with the first thirty years of experience. This is presented by comparing and contrasting the experiences with rice growing in Japan and Thailand. In both countries irrigation investments have been aimed mainly at paddy production and the policies and experience of both countries is illuminating as much from the differences as from the similarities. A separate section on the politics of irrigation is provided because this is, in the Audit's opinion, the most neglected aspect of irrigation planning. Both of these initial sections highlight factors that, with the benefit of a thirty year perspective, have been particularly important in understanding the flow of lending operations. The next two sections deal with the early (1950-67) years of lending and the middle years (1973-1980) respectively. The conventional audit report begins with the next section in which the most recent two lending operations are examined. This includes some of the most interesting and insightful material since most of the in-depth sector and subsector work done by the Bank was done after 1985 when lending had ceased and there was more time and resources to devote to analyses. The final section then seeks to highlight the lessons to be learned from a rich and varied experience.

II. Two Success Stories in Growing Rice

3. When it comes to irrigated rice culture, Thailand is something of a paradox. On one hand it is the premier rice exporter in the world, accounting for up to forty percent of international rice sales in recent years. It has never slipped below a rank of three in the world rice market in the last twenty years. On the other hand, it has consistently had the lowest fertilizer usage and the lowest average yields in rice growing Asia. This performance can be contrasted with Japan and Korea where fertilizer
usage and rice yields are the highest in the world. Yet, the latter two countries are generally considered to be successful at growing irrigated rice while Thailand's performance needs to be "upgraded and modernized".

4. The problem lies in differing perspectives and definitions. Japanese success is largely in the technology area while that of Thailand is in the area of economics. The need for modernizing and upgrading rice-growing technology in Thailand is almost always referred to by agriculture scientists and irrigation engineers - not development or macro economists. While Japan has by far the highest production cost for rice in Asia (four to six times world market prices), Thailand has one of the lowest costs of production. In 1985 it was estimated that the average cost per ton for producing rice in Thailand was about US$ 100. In the Chao Phya basin the cost could be as low as US$60 per ton. By comparison, the other major exporter of rice, the U.S., had production costs of US$ 180-200 per ton, double to triple Thai costs. Thus, the two major rice exporters in the world and the most technologically advanced in Asia have very different cost structures. Economic theorists would see the Thais expanding their production and exports, driving both the Japanese and the U.S. producers out of business. This has not been the case for reasons explained below.

III. The Politics of Irrigation and Rice Production

At the Macro Level

5. The Japanese approach to "success" in growing rice is well known - pay farmers several times prevailing world market prices for their rice together with subsidized rice research and intensive, extremely high-cost, public irrigation development. In 1975, Japanese farmers were receiving US$ 865 per ton for brown rice in 1975 prices and Japanese consumers were paying US$ 680 per ton for the same commodity. At that time, brown rice could be imported for US$ 200 per ton on the world market. On the investment side, Japanese irrigation and land consolidation investments were averaging about US$ 13,000 per ha. while the average for Southeast Asian countries was estimated at US$ 1,000 per ha. Such policies quickly led to overcoming the post WWII Japanese rice deficit and led to an embarrassing and costly surplus for export, requiring the setting of


2/ Thailand Irrigation Subsector Review, Projects Department, East Asia Pacific Regional Office, Report No. 5847-TH, April 25, 1986, Ch. III, pp.18-35.

3/ The term "rice", strictly speaking, means the grain available after threshing and milling the unhusked rice (paddy). Field yields and production tonnages are reported as unhusked rice. Milled rice is assumed to be about 65% of the weight of the paddy that produced it.

The setting of the annual rice procurement price quickly became a major political event in which rice farmers were pitted against the consumer groups and the Ministry of Finance, which had to finance the huge subsidy. The important lesson to be learned here is that a political decision was taken in Japan to achieve rice self-sufficiency and that a substantial transfer of income was made from the urban work force to the rice farmer to help effect that objective. The corollary to this is that irrigation engineering and agricultural science were necessary but not sufficient conditions to achieve the objective. Without very high and uneconomic financial incentives for farmers, the same agriculture science and irrigation infrastructure would have produced very different results.

In Thailand the situation has been far more complicated. The tax and export policies of the Ministry of Commerce have tended to discourage surplus rice production and exports from all rice farmers while the irrigation investment and cost recovery policies of the Ministry of Agriculture’s (MOAC) Royal Irrigation Department (RID) have tended to promote commercial production from a relatively select group of rice farmers in favorable geographic areas. The net impact of the contradictory Thai policies has been successful in a macro economic sense but, as should be expected from diametrically opposed policies unevenly distributed over time, space and income groups, both the benefits and costs can appear in

5/ The Audit is not critical of the Japanese policy to pursue a rice self-sufficiency objective at a high domestic cost. That is a policy the country desires for various non economic reasons and can afford. The Ministry of Finance and Parliament receive the bill for such a policy every year. Under these circumstances, most economists would applaud this sort of open decision to transfer resources for a specific non economic objective. The example is being used here because the transparency of the process in Japan makes an important point that is relevant for Thailand.

6/ Data for this discussion are taken from Chapter 5 of Farm Water Management for Rice Cultivation, Asia Productivity Organization, Tokyo, 1977. The article, Japan-1, was written by Mr. Takashige Kimura, Project Manager, Ootone Irrigation Project, Kanto Agricultural Administration Bureau, Ministry of Agriculture and Forestry, Yookaichiba-shi, Chiba Prefecture. It is unusual in that it was written by an irrigation engineer yet presents a comprehensive picture of technology as well as financial incentives.

7/ When Japan was undergoing its industrial development in the late 19th and early 20th century it financed much of that development with income transferred from farmers to urban industrial development. In the late 20th century the flow has reversed.

8/ There are, of course, many differences in climate, geography, factor prices and growing conditions between Thailand and Japan but they do not affect the point made here.
unexpected places. Unlike Japan, where the financial cost of rice self sufficiency is known and a mutually reinforcing policy is explicitly pursued, the net farmer incentive system in Thailand is not explicit political policy and must be inferred from examining actions and their results rather than stated intent.

7. Rather than drive down the international price with expanded exports the Thai Government (or part of the Thai Government) has chosen to sell a smaller volume at the higher price and tax away the monopoly profits. This has been justified by the political need to keep the internal domestic price of rice both low and stable. When world prices for rice were high, the Government has kept the high world price from being transmitted to the local economy by setting the effective rice export tax high to soak up the surplus between the desired low local price and the high world price. When world prices came down, the effective export tax was reduced. This has had the effect of generating fluctuating levels of quasi public revenues and stabilizing, at a low level, prices for the most important consumer good in Thailand. Unlike the Japanese case, the Thai farmers (pre 1982) received a much lower price for their production than would have been the case in a free market. (See Figure 1) Urban dwellers benefitted by receiving an important consumer good at prices lower than a free market would provide. As a result there has been a huge transfer of resources in Thailand from commercial rice farmers to urban dwellers, precisely the opposite objective currently pursued in Japan.


10/ In the "stable" years of 1960 to 1972, the total effective tax on Thai rice fluctuated between fifty and seventy-five percent of the domestic price. In the "peak" years of 1973-75, the effective tax climbed to a high of 171 percent of the domestic price in 1974. After the 1982 collapse in world rice prices, the tax wedge between domestic and border prices has remained at about ten percent.

11/ The Thai system for effecting this transfer is exceedingly complicated and it is only in recent years that the analysis has been done which allows us to make this statement. Part of the reason for this is that the official attempts at domestic rice price stabilization that are undertaken by the Ministry of Agriculture are generally ineffective. The real impact is made by export controls and taxes set up and presided over by the Ministry of Commerce. See: The Political Economy of Agricultural Pricing Policy: Trade, Exchange Rate, and Agricultural Pricing Policies in Thailand, by Ammar Siamwalla and Suthad Setboonsarng, World Bank Comparative Studies, 1989.
8. On the investment and technology side, the explicit policy was to alleviate rural poverty by providing public infrastructure in the form of roads, electric power and irrigation. The Thai success with roads and road transportation is well-known. A dense network of reasonably well-maintained roads serving the entire population is now in place and an extremely efficient privately owned bus and trucking industry is providing a variety of services at cost based prices to the bulk of the population. A similar success story can be told concerning the electrification of the countryside. The attempt to do the same thing with irrigation and water control has been less successful for reasons of geography and the uneven distribution of land and water resources. This, however, was not for lack of trying. The thrust of the government has always been to give free water to as many farmers as possible and this was the popular RID objective - develop large, medium and small scale schemes to the point where most farmers have control over water and most benefit from the public irrigation subsidy. The currently popular notion of the "greening" of the northeast is a direct descendent of the idea that access to the benefits of controlled water for most farmers is feasible with good engineering and agriculture extension.

9. By 1975, twenty-five years after the first Bank loan in the Chao Phya basin, officially irrigated land accounted for only 26 percent of the planted area. Most of this was supplemental irrigation in the wet season only. The fortunate farmers that had dry season water accounted for only four percent of the area planted in paddy. By 1982-83, the end of the era of large-scale irrigation investments, officially irrigated land was by then 30 percent of the area planted to rice. Dry season water was by then applied to seven percent of the planted area. Total paddy production from the period 1975/76 to 1982/83 increased by twenty-six percent with rainfed production increasing annually at about one percent and irrigated production increasing at about six percent. Rainfed production was sixty-one percent of total output in 1975-76 with irrigated production at thirty-nine percent. By 1982/83 rainfed production accounted for forty-eight percent of production with fifty-two percent coming from irrigated land. While these statistics show steady growth in irrigated production and a shift in shares of output, it is in the realm of dry-season production that the most dramatic changes were taking place. Growth in dry-season irrigated rice production over the period was at an average annual rate of seventeen percent with total dry season output increasing by about a factor of five. The share of dry season to total output increased from eight percent in 1975/76 to thirteen percent in 1982/83.

10. The message here is that rainfed paddy production remains an extremely important element of national output and that supplemental wet-season irrigation has been the main contributor to production increases. Dry-season production has grown rapidly from a small base but is still a relatively small share of output produced by a relatively small number of farmers.

12/ Thailand Irrigation Subsector Review, Projects Department, East Asia Pacific Regional Office, Report No. 5847-TH, April 25, 1986, Table 5.2, p. 44.
11. Yield increases were not spectacular. Average dry-season irrigated paddy yields in 1975/76 were 3.2 tons per ha. By 1982/83 this had increased to 3.3 tons per ha., still well below potential.

12. In spite of this modest technological progress, it was good enough to make Thailand the world's leading exporter of rice with a thirty to forty percent market share. Steady production increases were taking place while domestic consumption, in spite of a growing population and low stable prices, remained constant. The increments in production then went into the surplus for export. Macro economic success in the face of limited technological improvement continued to characterize the rice subsector. The reason for this "mixed" result is partially explained by the price factor analysis summarized above, an analysis that was not available to irrigation project specialists until four years after a thirty year lending program had ended.

At the Micro Level

13. The huge yield increases possible from combined use of irrigation, high yielding rice varieties (HYVs) and fertilizer (the Japanese technology) combined with low production costs and projected high world market prices provided impeccable economic arguments for proceeding with specific irrigation investments. The problem was that the financial arguments, given the large difference between the world market price and the farm gate price, were much more uncertain. By assuming moderately increasing effective export taxes and much larger increases in world and therefore domestic prices it was easy to produce a compelling financial justification also. If a cheap and stable domestic rice regime had been assumed the effective export tax would have to be assumed to increase appropriately with rising world prices and decline with falling prices and the financial justification would be less certain. The evidence now shows that the latter was the case pre 1972. Regardless of world market prices, farm gate prices were kept so low and stable that there was no compelling financial incentive to use the intensive technology to anything like its full potential. 14/

14. Equally important was the national policy of free water provided by a central government agency without financial accountability. The Royal Irrigation Department, unlike the sellers of electric power or

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13/ See for instance: Irrigation Project XI, Staff Appraisal Report, Report No. 2622-TH, November 26, 1979, Table 6.1, p. 33. The world market price of rice is assumed to increase in real terms by 50 percent between 1980 and 1990. The farm gate price of paddy used in the farm budget analysis is assumed to increase in real terms by 45 percent over the same period.

transportation services has no authority or incentive to charge users for irrigation water even though the users and beneficiaries are a relatively small and well-defined subset of the population. With no revenues other than general government allocations there was not the usual financial feasibility constraint that promotes both rational pricing of services and concern for the economic and financial goodness of investment projects. There were and continue to be no bottom line statistics by which the performance of RID managers can be judged.

15. The provision of free valuable public goods by an administrative bureaucracy to a select subgroup of the population provides the environment that leads to what economists call "rent-seeking" behavior. Public irrigation projects with free or subsidized water are extreme cases of incentives for rent-seeking. The value of irrigation water is usually much greater than what users are asked to pay. This difference is the "rent" associated with the good. In the absence of an impersonal market allocation mechanism the water and its associated benefit is obtained by other means. One of the principal micro effects of such an environment is that it pays for each individual irrigator to do whatever is required to get access to the scarce water within the scheme, regardless of the impact on the system at large and on the other irrigators. Repetto refers to this as the "assurance paradox". 15/ He explains it as follows:

Collectively, they would be better off if all abided by the system's operating rules and contributed to its maintenance. But, any single farmer would be better off if he shirked his obligations and took more than his share of water. On the other hand, he would be much worse off if he abided by the rules and nobody else did. The frequent result is that rules and cooperative behavior break down unless strong community traditions and sanctions protect against antisocial behavior. Without assurance that operators will impartially enforce the rules and run the system, conditions soon deteriorate into the populist anarchy that now exists in many public irrigation systems.

15/ For an excellent presentation of the rent-seeking phenomenon applied to the irrigation systems of the developed and developing world see: Skimming the Water: Rent-seeking and the Performance of Public Irrigation Systems, by Robert Repetto, Research Report #4, World Resources Institute, Washington, D.C., December 1986.
Thus, the political decision of the Thai government to provide irrigation water free by a centralized bureaucracy has potential macro economic as well as micro economic and engineering implications. There is considerable evidence that extensive rent-seeking behavior has been taking place in Thai public irrigation schemes including those under audit. 16/

IV. The Early Years 1950-67

16. In the seventeen years 1950-67 six water control projects were partially financed by the Bank. The first (LN 36-TH) was made in 1950 and was for the Chai Nat Diversion Dam on the Chao Phya River. This key facility and a system of main canals was to spread the wet season flood waters (storage for dry season use was not a feature) of the Chao Phya over some 600,000 ha. of the Northern Chao Phya Plain. Its initial objective was to provide supplementary wet season irrigation through semi-controlled inundation. With a single project, a large number of farmers in a very productive area were given improved, but not "modern" access to wet season water. Provision for upstream storage and hydroelectric power on the Ping River was then begun in 1957 with the Bhumiphol Dam Project (LN 175-TH) 250 km north of the Chai Nat Diversion Dam. When completed in 1964 this would firm up the wet season flows for the Northern Chao Phya Plain and increase substantially the dry season flows. In 1967, the Sirikit storage dam on the Nan River was started (LN 514-TH). It too was to provide electric power and firm up wet season flows and expand dry season irrigation in the Chao Phya Plain.

17. With the improved control of river flows in the most important rice growing basin in the country, the semi-controlled inundation delivery system was judged to be in need of improvement and a "ditches and dikes" program in the Chao Phya was financed in 1963 (LN 328-TH). This project was designed to provide the missing tertiary canal systems in the 600,000 ha. North Chao Phya Plain. This, however, was to be a low cost "extensive" form of on-farm development in which standards of water control were low. The latest available irrigation technologies were not yet being recommended. 17/

18. In 1963, the Bank partially financed the Petchaburi Irrigation Project (LN 327-TH) a 55,000 ha. scheme in the south, complete with storage dam, canals, ditches, drains and farm roads. Of more importance was the Mae Klong Irrigation Project (LN 394-TH) of 1965. This was the first step


17/ For an alternative presentation of developments during this period see paragraph 1-3 of Annex 1.
in developing the Mae Klong Basin which was the second largest rice growing basin in the country. The diversion dam at Kanchanaburi and the canals were to serve 120,000 ha. of wet season rice production with supplemental wet season irrigation. Upstream storage and dry season irrigation was to come later. These were the precursors of the two projects under audit in this report.

19. No further loans were made in the period 1967-1972. The first twenty years of Bank-supported projects began to come on stream, providing an improved but by no means "high tech" irrigation technology. The impact of all this began in the 1960s below the Chai Nat diversion dam in the Chao Phya plain. A partial picture of what was happening at that time can be obtained from the first audit report produced by OED in 1980. 18/ The water from Sirikit dam had become available in 1972 and, together with the water from the earlier completed Bhumiphol dam (1965), was having a large impact on dry season irrigation in the Chao Phya Plain.

In 1972, the area of dry-season cropping was about 107,000 ha. compared with a potential of about 450,000 ha. which could be supplied with water from Bhumiphol and Sirikit reservoirs. However, since 1972 the dry-season cropped area has grown rapidly and reached about 400,000 ha. in 1978. This was largely due to a sharp increase in paddy prices which rose from US$4.5 per ton in 1972 to US$11.5 per ton in 1978, providing strong incentives to farmers. About 200,000 ha. of the dry-season cropped area is now irrigated by low-lift pumps in the Southern Chao Phya plain in areas formerly devoted to a single wet-season crop of flood-dependent rice. In these areas farmers have given up wet-season cultivation in favor of dry-season cropping. The remaining 200,000 ha. are double cropped, of which 150,000 ha. are irrigated by gravity and 50,000 ha. by low-lift pumps.

When large amounts of dry season water became available in the Chao Phya Basin in the mid 60s and early 70s, farmers began to switch to dry-season rice cropping slowly at first and then rapidly after the Sirikit flows became available in 1972. The years 1968-72 were years of low domestic rice prices, and the incentive to grow more rice was not great even with the Bhumiphol dry-season flows commencing in the mid 1960s. The switch accelerated after the relatively high price year of 1973 in which nominal domestic prices increased by 44 percent and in real terms increased by 25 percent. Compared to 1978, the real increase over 1972 was a respectable 28 percent (not the more than doubling implied in the text of the PPAR above where current prices, rather than constant prices, are compared). 19/ The point is that the PPAR did pick up the significance of domestic prices on the extent of intensification the farmers were willing to undertake.


20. The other point is a frequently overlooked addition to rice growing technology at the time - the axial-flow low-lift pump. Of the 400,000 ha. of dry-season cropping undertaken in the Chao Phya Basin by 1978, about 250,000 was achieved with the use of locally manufactured low-lift pumps delivering the dry season water to fields from canals, drains, borrow pits, road-side ditches and ponds. In the absence of tertiary delivery systems, the local farmers found an "appropriate" technology to help them make use of the water that was spread widely over the countryside by the primary and secondary canal and drainage system that had been put into place.

21. Domestic production of these simple and inexpensive pumps commenced in 1957. By 1967 it was estimated that there were 80,000 in operation, mostly in the Central Plain. By 1975, the number had increased to 176,000. In 1983 there were estimated to be over 600,000 in operation, one unit for every 15 ha. of planted rice area, rain-fed and irrigated. While these, and an additional 260,000 centrifugal pumps, were not all used for growing rice, a great deal of them were. The extraordinary fact is that this technological innovation has received hardly any formal recognition by irrigation engineers in Thailand. It seems only to be discussed by the farm mechanization profession. The fact that Thai farmers had, in the late 1960s, partially solved the problem of how to deliver water from a system of primary and secondary canals and drains if the price of rice was attractive has escaped those interested in modern irrigation technology. It was not the way the Japanese did it. While the IRRI people did pick up the potential significance of this technology in 1983 in both Thailand and Vietnam, the economic analysis they performed showed only the superiority of the design over conventional centrifugal pumps.

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21/ Plusquellec points out the use of pumping in the lower Chao Phya and the beneficial effect on water use efficiency but does not suggest that this is something to be encouraged or exploited. See: Irrigation Design and Management: Experience in Thailand and Its General Applicability, World Bank Technical Paper Number 40, 1985, p. 31. He does the same thing in describing the desirable characteristics of the low-lift pump delivery technology in Egypt but notes that the technology raises the farmer's production costs (as does the use of fertilizer). See: Improving the Operations of Canal Irrigation Systems: An Audiovisual Production, The Economic Development Institute, World Bank, March 1988, p. IR 40.

22/ This is not strictly the case. In fact the Japanese may have been the first to use this technology successfully in the Saga Plain rice growing area in the 1920s. See: "The Development of New Techniques in Agriculture: The Case of the Mechanization of Irrigation in the Saga Plain Area of Japan" by Penelope Francks in: World Development, 1979, Volume 7, pp. 531-539.
pumps and the appropriateness of its use in low-lift operations. 23/ The possibility that canal (and drain) delivery systems might be consciously designed to incorporate this technology was not noted. 24/

V. The Middle Years 1973-1980

22. In the first seventeen years of Bank lending, six projects were undertaken. In the seven-year period 1973-1980, eight more projects were undertaken. Development of water resources, and the Bank's participation in that development, was accelerating. In the Chao Phya a series of three projects were undertaken. The emphasis was on finishing the work begun by approaching seriously the Japanese level of technological sophistication. In 1973 a pilot project on 17,000 ha. was undertaken (CR 379-TH). The idea was to build on the experience of a 1,800 ha. Netherlands-financed experiment in intensive on-farm development and land consolidation and a 700 ha. Taiwan-financed experience. If only the water control was dependable and precise enough and the fields were reshaped and leveled enough, the Thai farmer would employ other inputs to finally achieve the sort of "high-tech" operation that was associated with four to five ton per ha. yields.

23. This was followed in 1977 by a large-scale adaptation of intensive on-farm development for 63,000 ha. in the North Chao Phya Plain (LN 1468-TH), together with rehabilitation and improvement of the canal systems serving 138,000 ha. in the same area. The rehabilitation was to make up for the maintenance that was not being done on the earlier project and the improvement was to raise canal levels and improve the "command" area. In 1975, the Phitsanulok Project (LN 1149-TH) was undertaken in the extreme north of the plain above the Chai Nat diversion dam. It would take dry season water from the Sirikit storage dam before it reached the main part of the Chao Phya Basin and irrigate an additional 93,000 ha in the dry season. Given the World Bank's international rice price projections and plausible intensity and yield figures, all of these projects were economically feasible. It was also assumed that the high economic prices would be reflected in higher farm-gate prices and that farmers' net crop income would at least double and possibly triple.

23/ There is some question as to where the axial flow pump was first developed and commercialized for rice production, Thailand or Viet Nam. For the Viet Nam experience see: "The Motor Pump: A case Study of Innovation and Development", by R. L. Sanson, Oxford Economic Papers (New Series), 1969, Vol. 21, No. 1, pp. 109-121.


The Audit has been informed that numerous observers of the Thai irrigation scene had pointed out in the early 1970s the effectiveness of this farmer-initiated approach, but it never received formal recognition or Bank support as it did in the case of Bangladesh.
24. The other five projects supported by the Bank during this period were two "improvement" projects in the North East of Thailand (CR 461-TH and LN 1630-TH), the Ban Chao Nan hydro and storage project in the Mae Klong Basin (LN 977-TH), The Khao Laem hydro project also in the Mae Klong Basin (LN 1770-TH) and the Pattani hydro and storage project in the far South (LN 1485-TH). The projects in the North East were relatively small and were in a completely different climatic and soil zone of the country. The other three hydro projects were to be important storage facilities for the irrigation projects under audit in this report.

25. In early 1976 a six man mission from the Bank visited Thailand for about a month to prepare an Irrigation Program Review. 25/ It was the first comprehensive review of the irrigation subsector and was necessitated largely by the accelerating lending program and the severe difficulties encountered with implementation. It is an illuminating document in that it gives a good picture of the nature of the thinking that was going on at that time. The document is pure technology and physical planning and is completely devoid of any economic considerations. This is probably because the robust economics of irrigation development were already well-documented in previous staff appraisal reports and the economist's role in such a mission was considered redundant. Rice production became a simple function of domestic consumption and exports. Consumption became a function of population. Export levels were then determined either by assuming a constant share of Bank projections of international rice trade or a constant level of exports. By 1990 the country needed to produce 22.7 million tons of paddy. In 1976 it produced 15.1 million tons. Therefore, a 7.6 million ton increase was required over a 14 year period. A combination of yield, intensity and new area increases would do the job. The linkage between irrigation, yields and cropping intensity was assumed and the required increases in wet season and dry season coverage resulted. This could then be translated into specific projects. The problem then was how to get RID reorganized to put the new capacity into place. It was an engineering-management approach that was adequate, up to a point, by today's standards and completely adequate for the times.

26. The major flaw in the underlying analysis was the estimate of future domestic consumption. Per capita rice consumption was projected to increase from 165 kg in 1976 to 170 kg in 1990 requiring an extra three million tons by 1990 for consumption. In fact the per capita consumption has steadily declined since the early 1970s reaching a level of 138 kg in 1982/83. 26/ This decline was already in evidence by 1976, with a peak consumption level of 182 kg in 1970/71. 27/ The entire consumption and export demand picture for rice, which drove the resulting irrigation investment program received one and a half pages of text and one table in the entire document. In a twenty-six page annex on agriculture there is no


26/ 1986 Irrigation Subsector Review, Table 5.1, p. 43.

discussion of prices or government policy affecting prices. The simple and
more defensible assumption that per capita rice consumption would stay
constant would have nearly halved the increment in required production. A
decreasing consumption rate would have raised serious questions about the
urgency of the irrigation investment program. This latter possibility is
handled by the following statement:

If actual production starts of get ahead of domestic consumption and
export needs, it would be easier to scale down the irrigation program
accordingly than to increase it in the face of major shortfalls.

The above quote is particularly revealing of the narrow and fundamental
assumption that irrigation investment, and the lack of it, is what
increases or decreases rice production in Thailand. There was no place for
consideration of world market prices or, more importantly, farm-gate
prices. 28/

27. The document did pick up the fact that even though the Northern
Chao Phya Basin had received most of the irrigation investments for dry-
season cropping, the big increases in dry season production had mostly
(over 60%) come from the Southern Plain where farmers, receiving dry season
water from Sirikit and Bhumiphol Dams, had abandoned low-yielding wet-
season rice subject to flood damage to irrigate high-yielding dry-season
rice with water pumped from improved drainage canals. The early Bank-
supported investments in dry season storage were paying off, but not quite
the way the engineers had anticipated.

28. The Review also made the first mention of a serious developing
problem: Dry-season water in the Chao Phya was limited and needed to be
allocated between regions and projects as well as within project areas.
Without dry-season water and dry-season benefits, it would be difficult to
justify more irrigation investments in the Chao Phya Basin. For a specific
project, the problem was how to allocate scarce dry season water. The
report points out that the revealed policy of water allocation was to allow
those close to the canal system to get water in the dry season. This led
to ribbon development along main canals and laterals. A preferable
alternative would be the "Golongan" system of Indonesia where all dry
season water is delivered to a particular sub area every two or three years
on a rotational basis. The latter required RID control and farmer
discipline and cooperation, all of which were missing. Farmer damage was
substantial and water user groups were not working. Rent-seeking behavior
was clearly manifest. Unfortunately, the fundamental incentives for this
behavior, i.e. free scarce water allocated by a canal bureaucracy was not
recognized. Instead, the hope was that the problem could be remedied with
a reorganization of RID, allocation of adequate O&M funds, well-trained and
motivated operational staff, better planning and monitoring, and above all

28/ The Audit is not trying to make the equally extreme point that the
farm-gate price of rice is the only determinate of production levels.
The provision of supplemental wet-season and dry-season water in the
Chao Phya, agriculture extension services, and the post 1972 rice
price regime interacted to produce an impressive macro economic
result.
a level of canal delivery and distribution technology that would allow
precise on-time delivery of scarce water. Good management and good
engineering would set things right. 29/ 30/

29. The other useful document dealing with this time is the first audit report of an irrigation project in Thailand, produced by OED in early 1980. 31/ It reports on the 1967 Sirikit Dam Project and the 1973 Chao Phya Irrigation Improvement Project. The 1973 project was a small (17,000 ha) scheme designed to demonstrate ways to overcome the pre 1972 slow growth of dry season cropping in the North Chao Phya Plain. Since the cropping intensity quickly went to 190 percent a year after completion it was judged a technological success. The audit then pointed out:

   It is now apparent that the low paddy price prevailing prior to 1972
   was the main constraint on the use of dry-season water.

30. Of more concern to the 1980 audit was the basin-wide shortage of dry-
season water in the Chao Phya.

   There is not even enough water to obtain full benefits from the last
   two Bank-assisted projects: Phitsanulok (Loan 1149) and Chao Phya II
   (Loan 1468).

   Why did the Bank approve two loans (Loan 1149 of 1975 and Loan 1468
   of 1977) for irrigation projects which would push water demand beyond
   the overall basin's water availability ceiling...?

   The audit provides a partial explanation:

   The Bank's decision to support the Chao Phya I project was made
   before the spontaneous expansion of dry season cropping and its
   implications became apparent. The decision on Phitsanulok was made
   when some information was already suggesting that water supply might
   not be fully adequate for the project. However, both the cropping
   trend and its implications were fully apparent when the Chao Phya II
   project was appraised in 1976. 32/

   For the case of Chao Phya II Project, undertaken in 1977, no satisfactory
   explanation was ever given. It was the last Bank-supported expansion
   scheme to be undertaken in the Chao Phya Basin.


30/ For an alternative view of the same developments during this period
   see paragraph 4 of Annex 1.

31/ Thailand: Sirikit Dam and Chao Phya (First) Irrigation Improvement
   (Loan 514-TH and Credit 379-TH), Project Performance Audit Report,

32/ Audit's emphasis.
31. By 1978, efforts were being made to reduce the size of the dry-season planting in the Chao Phya Basin to match the water available. The size of the crop in that year actually increased. The same thing happened in 1979. In the serious drought year of 1980, the cut-back finally took place but it is not know if this was due to administrative efforts or the physical lack of water. By 1981 the dry-season crop area was at a record level and RID now has the permanent "problem" of dealing with too much dry-season cropping capacity and too little water. 33/ 34/

VI. The End of an Era 1980-90: The Mae Klong and Pattani

32. By the late 1970s, it was clear that the large-scale irrigation development of the Chao Phya had gone too far. Too large an area was served by irrigation infrastructure though critics were quick to point out that it all needed "modernizing" if the full benefits of the investment were ever to be realized. In the 1980s attention then turned to the water-surplus Mae Klong Basin which had begun the main diversion dam in 1965 (LN 394-TH) and the first upstream storage dam in 1974 (LN 977-TH). A second hydro and storage dam was undertaken in 1980, the Khao Lam Project (LN 1710-TH). The pattern was similar to that followed in the Chao Phya Basin: first a diversion dam and canal system for spreading wet season flows, followed by upstream storage to firm up wet season flows and provide dry season water, followed by more upstream storage. The stage was then set for the development of the Mae Klong in a manner that would avoid the shortcomings experienced in the Chao Phya. It was also time to follow up on the Pattani hydro investment of 1977 (LN 1485-TH) in the extreme south of the country where the storage provided for generating electricity could also be used for irrigation.

33/ In order to provide efficient irrigation in the wet season in high rainfall areas it is generally the case that the wet season infrastructure coverage exceeds what can be served in the dry season. In this sense the development was to be expected and, up to a point, can be justified provided it is considered explicitly in the economic analyses. Theoretically optimal supplemental wet season irrigation in relatively high rainfall areas does, however, raise serious social and technical problems. There is the obvious problem of rationing water in the dry season. Less obvious, but potentially more serious, is a wet season drought leading to serious farmer damage to the infrastructure, a classic case of rent-seeking behavior. See: *India Irrigation Sector Review: Irrigation Management on the Indo-Gangetic Plain*, by D. J. W. Berkhoff, Asia Technical Department, World Bank, June 7, 1990.

VII. Project Objectives, Definition and Design

33. Both the Mae Klong and Pattani projects were on-going operations whose overall dimensions had been decided many years earlier. In most cases a good deal of engineering and construction had already been done. The task was to rehabilitate, upgrade and expand - complete what had been started and repair what had not been maintained. Irrigation XI comprised the Mae Klong Right Bank Scheme and the Pattani Right Bank Scheme, while Irrigation XII was for the Mae Klong Left Bank scheme only. In terms of technology, the idea was to provide a form of on-farm development (OFD) for 66,000 ha. on the Mae Klong Right Bank, 27,000 ha. on the Mae Klong Left Bank, and 15,000 ha. on the Pattani Right Bank, a total of 108,000 ha. The OFD proposed would give most plots direct access to a tertiary canal which commanded the surrounding land. Intensive on-farm development which involved land leveling and boundary realignments to effect efficient grid patterns of the Japanese model was too costly to consider. 35/ The plots would have access to supplemental wet-season water and adequate dry-season water to allow improved wet season rice yields and a high yielding second crop in the dry season.

Project Brief

34. At the Project Brief stage (1979) for Irrigation XI, RID had already constructed the main canals and laterals to serve about 43,000 ha out of a 66,000 ha service area. The Bank was to finance the completion of the irrigation and drainage system for this area on the Right Bank of the Mae Klong. In addition, RID had also completed the Right Main Canal of the Pattani project in the South. This canal was to serve 18,000 ha of farm land. Again, the Bank's financing was to support the completion of the secondary canals and tertiary system for this 18,000 ha service area. There were no issues to be resolved. According to the Irrigation XII Project Brief (1980), only the Malaiman area on the left bank of the Mae Klong was to be served. A 60,000 ha service area of paddy land was to be irrigated. Three quarters of the intended service area already grew wet-season rice and one quarter produced a high-yielding dry-season crop by irrigation provided by low-lift pumps from nearby streams, canals and drains. The two issues identified at that stage were finance (too large a loan for the lending program) and the difficulty with cost recovery.

Issues-Decision

35. At the Issues-Decision stage for Irrigation XI there had been no changes in the Mae Klong subproject, reflecting the advanced preparation of the project. For the Pattani subproject in the south, the service area had been reduced from 18,000 ha to 15,000 ha because of the discovery of 3,000 ha of sandy soils unsuitable for irrigation. While it was not raised in the Issues Paper, the Decision Memo discusses the desirability of the Government imposing some direct charges on water users to make some

35/ The Japanese aid program (JICA) financed intensive pilot projects on both banks of the Mae Klong and the results verified the extremely high and uneconomic cost of land leveling and land consolidation that is a characteristic of this technology.
contribution towards O&M costs. The zero user charge regime that prevailed was also an obvious incentive to use scarce water inefficiently. \(^{36/}\) The decision was to try to get the Government to do something. For Irrigation XII, the 60,000 ha service area had been reduced to 27,000 ha in order to scale down the loan size. The Issues Paper notes that sugar cane is as important a crop as paddy in the service area but that only the paddy area would receive priority attention. No issues needed resolution. The Decision Memorandum concentrated on the need to reorganize RID so that there was clear responsibility for the delivery of water to farmer's fields. Intensive on-farm development required skills and resources different from the earlier construction-oriented water-spreading operations, a position that was, in retrospect, insightful and accurate. A penned note from the Senior Vice President of Operations exhorted staff to move on these long-overdue institutional issues.

**Negotiations**

36. At Negotiations for Irrigation XI, the cost recovery issue was addressed. It was agreed that enabling legislation would be drafted promptly and that a capital cost recovery study should be completed by 1982. For Irrigation XII, the cost recovery issue was also raised. The Government informed the Bank that the enabling legislation had been drafted and approved by the Cabinet. Subject to the passing of the legislation, the Government would (i) submit proposals for O&M fees by June 1982, (ii) collect O&M charges from individual farmers within one year of tertiary system completion, (iii) submit proposals for capital recovery charges by December 1984, and (iv) collect capital recovery charges from individual farmers within three years of completion of tertiary systems. Reorganization of RID was also discussed. The Bank enquired about the impact of the 1979 Organization and Administration Study. The Government had set up a subcommittee to consider the matter. A Plan of Action was to be prepared by January 1982 to assist in implementing the subcommittee's recommendations.

**Economic and Financial Justification**

37. The economics of the lending operations were pretty straightforward. Cropping intensities were to rise from 105 to 190 percent in Mae Klong Right Bank, 100 percent to 170 percent in Pattani Right Bank and from 100 percent to 178 percent in Malaiman - Mae Klong Left Bank. Dry season paddy yields would achieve 4.2 tons per ha in Mae Klong Right Bank, 3.5 tons per ha in Pattani and 4.0 tons per ha in Malaiman. The Irrigation XI SAR utilized the World Bank's price projections for rice in 1990 and showed

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\(^{36/}\) The position that the effective rice export tax, pre 1982, was a surrogate user charge imposed on commercial rice farmers is defensible on equity grounds but not on economic efficiency grounds. The marginal cost of unpumped canal water is near zero and the incentives for destructive rent-seeking behavior undiminished.
a fifty percent increase in real terms over 1980 levels. 37/ The Irrigation XII SAR showed a 17 percent increase in 1990 over 1981 levels. 38/ The quite good sensitivity analyses that accompanied the economic analyses showed that for, Irrigation XI, only a 55 percent decrease in rice rices from 1980 to 1990 would render the investment uneconomic. A similar analysis for Irrigation XII indicated that only a 26 percent decrease in real terms from 1981 to 1990 would render the investment uneconomic. These were considered, at the time, to be highly unlikely events.

38. On the farmer incentive side the 1979 Irrigation XI SAR displays a partial understanding of the impact of Government tax and export policies on domestic prices. The Irrigation XI SAR shows an effective 1980 export tax of Baht 1580 per ton of rice which converts to about Baht 975 per equivalent ton of paddy. With a domestic (input price of paddy at mill) financial price of paddy of Baht 2600 per ton, the effective export tax is 37 percent of the domestic price. A year later, the Irrigation XII SAR shows an effective 1981 export tax of Baht 2400 per ton of rice which converts to about Baht 1560 per ton of paddy. The domestic financial price of paddy is Baht 4,000 per ton so the effective export tax is about 39 percent of the domestic paddy price. In Siamwalla et al, the total effective paddy export tax in 1980 and 1981 is estimated at Baht 1525 and Baht 1742 per ton respectively while the domestic paddy prices are estimated at Baht 3403 and Baht 3951. This yields tax percentages of 45 percent and 44 percent in 1980 and 1981 respectively. The difference is the value of the so called "quota rent" that exporters must pay to obtain export quotas. Since this is an unofficial tax that is imputed from market data it does not find its way into conventional farm budget analysis. In the peak world price years of 1973 and 1974 quota rents were estimated to be respectively 36 percent and 20 percent of the total effective export tax in those years. In 1980 and 1981 they were estimated to be 18 percent and 13 percent of the effective export tax. This element of the effective export tax was (understandably) excluded from the SAR analyses.

39. More important on the farmer incentive side is the assumption that farm-gate prices would be allowed to rise just as world market prices were predicted to. Thus, in the SAR for Irrigation XI financial farm-gate prices were assumed to increase in real terms by 45 percent over the period 1980-90 and remain at that increased level thereafter. A year later with Irrigation XII the assumed growth of the same factor over the period 1981-90 was a more modest, but still a substantial 18 percent. These assumptions, together with the cropping intensity and yield assumptions led to approximately a doubling of net farm income for Irrigation XI and a doubling of net small-farm (2 ha) income and a tripling of large (5 ha) net farm income with Irrigation XII. Thus, both the economic and the financial


analyses were consistent. The fundamental assumption that allowed such an outcome in the financial analyses was that Government effective export tax rates would remain constant for the future and would not rise with rising prices and drop with declining prices. To do otherwise would have required a very careful econometric analysis of past effective export taxes and this (again understandable) is not the sort of detail that can be incorporated into conventional irrigation project analyses.

Engineering and Technology

40. The engineering and technology associated with these schemes is worth noting at this stage as it becomes much more of an issue in the latter stages of this report. The basic design incorporated open canal gravity flow technologies with upstream control structures that assumed that the operators of the system could match the demand for water with the supply by manipulating the various control structures at the primary, secondary and tertiary level. Thus, a part of the scheme that had just experienced intensive rainfall would not receive water, while dry areas needing water would receive it. A public, salaried canal bureaucracy would integrate the feedback from the farm fields with the supply of water and the needed gate settings.

41. In the case of the Mae Klong, this process was to be computer assisted and the program and its use was given the name of Water Allocation Scheduling and Monitoring System, the WASM System. It was a simplified version of the Pasten system developed by the Dutch in colonial Indonesia before the age of the computer. 39/ An integral part of such a system is the ability to send measured flows of water down a particular canal in response to demands. This means that certain key control structures must be able to allow measured flows to pass, not unlike a meter/valve in a pipe system. In open canal systems various techniques are used to set these measured flows. In the case of the Mae Klong, Dutch engineers were designing the system and they incorporated the Romijn weir, an overshot moveable bed weir invented by the Dutch for the Indonesian systems in the 1930's, into the system. It can, in the hands of a trained operator, be used to allocate a measured flow from a main channel into a branch channel. In the case of the Pattani scheme, designed by an American firm, the basic flow measuring device was to be the constant head orifice (CHO), an undershot double-gate developed for use in U.S irrigation systems by the Bureau of Reclamation. Like the Romijn weir it too could, in the hands of a trained operator, allocate measured flows. The CHO was incorporated in much of the early irrigation systems of Thailand largely because of the influence of the U.S. Aid program and the engineers associated with that effort. The WASM computer-assisted system of water allocation was also eventually specified for implementation at Pattani.

42. It is also interesting to note at this point that the Project Brief for Irrigation XII stated that twenty-five percent of the project

area was already irrigated by low-lift pumps in the dry season to produce a high yielding rice crop. 40/ Nothing was made of this spontaneous use of an appropriate technology except to assume that it would be displaced by a free gravity canal system.

Politics

43. The Mae Klong basin is one of the more favored areas in Thailand due partly to its natural resources of soil and water and partly because of its proximity to the major urban area of Bangkok. Crop diversification is well advanced because of the market for fresh fruits and vegetables in nearby Bangkok and because of a variety of appropriate soil types.

44. It is also the location of much of the sugar milling capacity in the country. Sugar cane is an important and profitable crop because government pricing policies have made it so. As the Japanese have done with rice, the Thais have done with sugar. The domestic price of sugar in Thailand is higher than the world price because imports are not allowed and cannot compete with domestic production to drive prices down. The various local sugar mills compete for their share of the domestic market, which is very profitable, and export what they cannot sell domestically at low world market prices. The larger the domestic share of production the mill has, the more profitable the operation. Just as the annual rice price decision is an important event in Japan, the annual cane price and domestic sugar price decision is an important event in Thailand. This is a political event with financial and economic implications. 41/ The Bank generally stays out of projects where economic efficiency is of secondary importance and support of the sugar industry has not been high on the list of areas where help is needed. The presence of large sugar cane producers (67,000 ha.) in the Mae Klong Left Bank then presented a problem since they too would benefit from the free irrigation infrastructure as would the poor rice farmers (63,000 ha.). This was dealt with by limiting the areas of Bank-supported development to a portion of the rice growing area (27,000 ha) and by not providing the tertiary canals and drains to serve the cane growing areas in the project. Outlet structures would be provided, but the cane growers would have to construct and maintain their own water delivery system. The emphasis was on paddy production. 42/

45. The situation in Pattani was very different. The area is far from Bangkok, just north of the Malaysia border and many of the farmers have strong cultural affinities to the Malay speaking Muslims to the South, making them a minority group in the country as a whole. In addition, the

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40/ Project Brief, July 31, 1980.


42/ For an alternative view of the sugar situation see paragraph 2 of Annex 1.
Malaysia border area on both sides was the site of insurgent activities during the 1950s and 60s that both countries eventually controlled with successful efforts at pacification and economic development. Per capita incomes in the area were lower than the national average and poverty alleviation and regional development were major government concerns. Infrastructure in the form of roads, electric power, schools, clinics and irrigation were part of this initiative. The case for doing something in this area went well beyond the desire to increase paddy production.

VIII. Project Implementation

46. In the Mae Klong Right and Left Bank projects, most of the primary and secondary rehabilitation and extension works were completed. However, of the 66,000 ha service area of the Right Bank, only 37,700 ha of the tertiaries and on-farm development (OFD) took place. On the Left Bank, only 22,000 ha of the original 27,000 ha service area was covered with the OFD work. Overall for the Mae Klong, only 62 percent of the tertiary system was put into place by the time of loan closing in late 1988. The problem here was that about 38 percent of the farmers either did not want or could not agree on the high tech tertiary development that required land without compensation. 43/

47. In the Pattani scheme the problem was more serious: the farmers initially did not want any on-farm development. Only 4,300 ha of a planned 15,000 ha of OFD was completed some nine years after the loan was signed and OFD development continues well after loan closing. The main and secondary canals were delayed also because of contract administration problems.

48. The problem with OFD acceptance came as a shock to the engineers trying to implement the projects. After the fifth supervision mission of Irrigation XII in 1985 the problem of actually making the system work as designed was beginning to be apparent. In the Mae Klong it was assumed that the lack of cooperation of the farmers stemmed from their lack of understanding of how the OFD would benefit them. An intensive program of farmer training was subsequently undertaken together with the WASM initiative. The consultants made an all out effort to address the problem of farmer resistance and mobile teams of educators were fielded with audio-visual presentations designed to explain the benefits of the project and allay fears. In the Pattani scheme things were more serious. There was a fundamental lack of trust between the engineers and the farmer beneficiaries. Accepting tertiary development meant giving up title to scarce land without compensation to the government before getting the civil works. To do this requires not only the belief that the civil works are beneficial but that they will in fact be put in place. To build trust requires more time and effort than building canals. This is being accomplished at Pattani, but at a pace much slower than envisioned in the project proposal.

43/ For a more positive view of this development see paragraph 6 of Annex 1.
49. Two other sources of delay were the protracted procedures involved in letting contracts in Thailand and the need to resurvey areas where the original surveys were not adequate. The former problem was expected and progress in RID administrative reform was expected to alleviate it. The latter problem came as an unpleasant surprise. However, it was "lack of farmer cooperation" that has provided the bulk of the explanation for why Irrigation XI's closing date was extended three years and that of Irrigation XII by two years without nearly approaching complete OFD coverage in the service areas.

50. Progress in the area of the much sought after RID administrative reform was monitored early in the supervision cycle of Irrigation XII where an action plan and attention to implementation of the plan was a specific covenant in the Loan Agreement. A public administration expert accompanied the first supervision mission in November 1981. He produced a thoughtful analysis in an annex to the main report. The basic thrust of the report was that the 1979 consultant recommendations promoting decentralization and delegation of authority by the Director General was counter to the Thai bureaucratic tradition of highly centralized control and that progress was likely to continue to be slow since the issue was being taken up by a series of committees. In April 1982 an RID Action Plan was submitted to the Bank. There was a flurry of activity in the Bank to follow up on the RID initiative and the same public administration expert accompanied the second supervision mission. In their report of January 1983 it was stated that a separate working paper on public administration would be issued. There is no copy on file. In the third supervision mission report of July 1983 the issue received one paragraph to the effect that some more draft plans were being prepared. The issue was eventually given less attention than the problem of implementation of the OFD component.

51. The other big institutional objective was to begin to collect irrigation user charges. This was a covenant under the Irrigation XI Loan Agreement. The enabling legislation had been drafted and approved by the Cabinet prior to negotiations. Everything hinged on the passing of the proposed law by the Thai legislature. Since this never happened, the detailed agreements for implementation were never triggered. A free water policy continues to be the official position of the Thai government.

52. During implementation of the Mae Klong Left Bank under Irrigation XII a particular issue rose that gives a very useful insight into the thinking of canal engineers at the time. In October 1984 the question was raised by Bank staff concerning the extraordinary amount of fill required in order to "command" the service area of sublaterals 3R, 5L, and 2L. Full supply level (FSL) was one to three meters above ground level because of pockets of high ground that were to be served. The suggestion was made that the FSL be reduced and the pockets of high ground served by pumps, thereby saving millions of cubic meters of earth excavation and compacted fill. In December 1984 the consultant's response was received. They agreed that reducing the FSL by 0.5 meters would leave about 270 ha. "out of command". Not serving these areas with water above ground level, regardless of the cost, was considered to be undesirable since those not
receiving this facility would cause problems and serving scattered areas by pumping was not feasible. This was the end of the discussion. 44/

IX. Project Outcome

53. In the end, $25.6 million of the $80.0 million Irrigation XI was cancelled, while $22.6 million of the $57.0 million Irrigation XII was cancelled. The retrospective rates of return of the two Mae Klong projects are now in the 7-8 percent range while that of the Pattani scheme is around 5 percent. This assumes that another 7,000 ha. of the Mae Klong Right Bank OFD work will eventually be done after loan closing and another 9,000 ha. of the Pattani OFD work will be accomplished. If one considers the heavy pre-project sunk costs excluded from the economic analyses then the economics of these high tech schemes providing wet and dry-season water are not very impressive. Not only is the price of rice low at the farm gate, it is now so low in the world market that even with the assumptions concerning yields and cropping intensities actually taking place, the economics of such schemes no longer make a persuasive case for going forward.

54. Added to this sobering development is the evidence that the high tech elements of the system that have been implemented are not at all being used as the engineers intended. Few of the key structures in the Mae Klong and the Pattani have been calibrated - so measuring the major flows is impossible even if it were desired. 45/ Despite the assertion in the PCRs that the WASM system was a success and should be implemented throughout the country, it was quite clear to the Audit that it was not being used at all to manage the system either in the Mae Klong, where it was first developed, or in the Pattani, where it was to be introduced. Most of the key structures are not calibrated and many of the tertiary offtakes have been damaged by farmers, especially in the Mae Klong. 46/ In addition, RID is

44/ The Region is of the opinion that in such circumstances it is extremely important to have all the farmers supporting the irrigation investment and this means giving each gravity service if technically possible. Beyond this, there is the logistical problem of providing pumps, spare parts and fuel in rural areas.

45/ In the Pattani scheme many of the CHOs did not even have the second gate installed which meant that the remaining gate was used simply in an "on" or "off" position, something that could be accomplished with a much simpler and less costly structure.

46/ RID does not keep an inventory of damaged or inoperable structures but the Audits observation was that as many as ten percent of the tertiary offtakes were damaged after only three years of operation. Interestingly, the gate operators say that most of the farmer damage takes place in the wet season when the irrigation is supplementary to the usually substantial rainfall. This is consistent with the recent findings by Berkhoff in the Indo-Gangetic plain. See: India Irrigation Sector Review: Irrigation Management on the Indo-Gangetic Plain, by D. J. W. Berkhoff, Asia Technical Department, World Bank, June 7, 1990.
having great difficulty in recruiting, training and keeping gate operators who could operate the system even if it were operable. The rapid private sector industrial development of the country is attracting most of the numerate graduates of technical schools. Finally, rent-seeking behavior on the part of farmers is clearly present. Visible proof of this, beyond the damaged control structures, is the numerous permanent pipe installations that regularly pierce the primary and secondary canal banks to take water on demand either by syphon or by pumping.

55. In the end, approximately 7,300 ha of sugar cane benefitted from the Bank-supported Mae Klong investments. The use of the irrigation system for cane is enlightening since cane growers were not offered the OFD facilities given the paddy farmers. The sugar farmers had already supplemented the rainfall with tube well irrigation pre project. The provision of free surface water in the dry season under the project was welcomed as it displaced the farmer-financed tube well operations. Rather than construct tertiaries to "command" the cane fields, the cane growers chose to drop the water from the public off-takes into ditches leading to the cane. From the ditches it is being pumped by low-lift pumps into the furrows as required. Embankments, compaction, and field outlets were avoided and the land lost for tertiaries was minimized.

56. Another unique feature in the sugar area was the planned use of night storage in the canal system. Instead of excavating borrow pits outside the canal banks, the excavation took place between the canal banks which were pushed to the extreme edge of the canal right-of-way. This created a large pond or reservoir in the canal system right-of-way which outlet was controlled by a downstream control structure. At night the reservoir was charged so that in the morning the cane farmers could take water out of the canal below the reservoir. As the level of the downstream canal water dropped, the outlet control structure for the reservoir automatically opened to release the night storage. This is a technology dramatically different from that used in the rest of the Mae Klong. Rather than upstream manual control by a canal bureaucracy it allows automatic control driven by the real time downstream demand of the cane farmers. The use of this simple mechanical technology together with ground level tertiary ditches and low lift pump final delivery is an extremely interesting manifestation of public and private cooperation employing elegant engineering with local pump technology and farmer financial incentives. For this reason the pilot sugar irrigation element of Irrigation XII is one of the more interesting initiatives taken under the project. Unfortunately, the experience is not taken up in the PCR because the relatively well-off and subsidized cane farmers were not the main thrust of the lending effort. The less well-off and taxed paddy farmers were being treated to an entirely different engineering approach that wasn't working very well.
X. Findings and Issues

The Macro Economic Picture

57. The Bank got involved in supporting irrigated rice production in Thailand during a period in which world market prices for rice were high relative to Thai production costs and the revenues from the effective export tax on rice were important for the public finances of the country. When cost reducing irrigation infrastructure providing supplemental wet-season and dry-season water came on the scene in the mid 1960s the high rice tax and resulting low domestic price for rice militated against the rapid intensification expected. More appropriate price incentives were introduced from 1973 on, during a time of unprecedented high world market prices. Paddy production, led by supplemental wet-season irrigation production expanded steadily.

58. On the export scene two important factors were operating. Thai population growth was slowing to 2.0 percent per year, and the per capita consumption of rice was declining at roughly 2.0 percent per year. Domestic rice consumption remained about constant over the ten year period and the entire increment in output had to be exported. By 1982, when world rice prices collapsed, Thai exports were about four times their 1972 levels. The tax wedge between world and domestic prices had shrunk to less than ten percent and the Ministry of Commerce had much less flexibility in manipulating domestic and world prices. By 1989, Thai rice exports accounted for 41 percent of the international market and Thailand has become the main player in that market, albeit at price levels about 50 percent lower in real terms than pre 1982 levels. The high cost producers such as the U.S. are slowly leaving the market. Extremely low cost producers such as Viet Nam are now entering the market. 47/

Underlying Structural Changes

59. Beyond the issues of farm-gate prices and free canal water, developed above, it is possible to identify a number of important structural changes that were taking place in the Thai economy and society that were to have a great impact on how irrigation schemes were to perform. These come under the headings (i) declining relative importance of rice, (ii) part time farming, (iii) public sector skill shortages, and (iv) urban and industrial competition for water.

60. By the mid 1980s it was clear to the Thais (but not the Bank) that world rice prices were likely to remain low for the indefinite future. 48/ Per capita rice consumption was declining as per capita income increased. Rice exports were less important in a government revenue sense.

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and in the balance of payments as other crops and manufactured exports expanded. The economics of small scale irrigation were not good nor did new large scale rice systems any longer make economic sense as they had in the time of high world rice prices. 49/ In addition other low cost producers are entering the world rice trade, China in some years and recently Viet Nam. Crop diversification is seen as the next step in the evolution of Thai irrigated agriculture. While rice production will always be important, the simple days of irrigation for rice only are coming to an end. Given the vigor of the Thai food processing industry and its links with agriculture production, diversification will certainly come. The question is what sort of irrigation technology is appropriate for the future.

61. Thai farmers have been obtaining over half their family income from off-farm activities for many years and the poorer the rice farmer the larger his off-farm share. 50/ Rice farmers, especially poor rice farmers, were part time farmers. They could not organize their lives around irrigation operations and water user groups. That kind of cooperation costs them time and money and, unlike the Japanese case, the cooperation could not be bought with rice prices several times world prices. Had the price incentives been offered, the problem then would have been what to do with all the rice. Whatever technology is adopted for irrigation in Thailand it will have to take into account the reality of a small scale part time farming population with alternative productive uses for their time. 51/ The on-demand piped systems that have evolved in Japan reflect this reality there but their capital cost per ha. makes no sense economically for rice production in Japan or Thailand.

62. There is a growing demand by the rapidly expanding private industrial sector for technically trained personnel. Public sector organizations paying government wages are increasingly finding it difficult to recruit and retain potentially skilled people. RID is finding it difficult to recruit good irrigation engineers. Even more critical is the shortage of people who can operate the high tech irrigation schemes that exist now. Manual operation and twice-daily adjustment of thousands of control structures requires intelligence and training. A large number of these people are needed to operate the most up-to-date irrigation schemes in the country but they are not available. Without them it makes little

49/ Thailand Irrigation Subsector Review, Projects Department, East Asia and Pacific Regional Office, Report No. 5847-TH, April 25, 1986, p. 60 for small-scale evidence and pages 105 and 106 for large and medium scale.


51/ A recent survey in the North East has shown that farm sizes there are actually beginning to increase. If this is true it may indicate that farmers are beginning to leave agriculture permanently and that large scale full-time farmers in fewer numbers are coming onto the scene.
sense to go through the fiction of a water allocation plan, with or without computers. Whatever technology is adopted for public irrigation in Thailand, it will also have to take into account this reality.

63. There is increasing competition for scarce water by the urban and industrial users of Thailand and a growing problem of water pollution and water quality. For surface supplies the problem of a water shortage in the Chao Phya basin is manifest. Inter basin transfers from the Mae Klong to the Chao Phya are already taking place and other possibilities are receiving increasing attention. Surface water is becoming increasingly scarce and valuable yet its marginal cost for the fortunate few who receive it at public expense is close to zero. As long as canal water is free it is unlikely to be used efficiently and water intensive rice production in the dry season will be encouraged even though prices are low and there may be better uses for the water. Private groundwater development, such as that undertaken by the sugar growers in the Mae Klong before Irrigation XI and XII, is going to be discouraged as long as free canal water is provided. Except for urban areas, the Thais have hardly addressed the subject of ground water. 52/ The bias of the Government and RID for free public surface canal irrigation systems will eventually have to be reexamined for possible correction if the shortages become serious enough.

Modes of Thinking About Irrigation

64. The dominant concept of irrigation in Thailand has been and remains that of open canals delivering free water to the root zones of plants by gravity. The means for doing this was through a large canal bureaucracy dedicated to matching the demand for water with the supply by frequent setting of gates and flow measuring devices. When demand exceeds supply the same bureaucracy then applies a rationing system designed to achieve an equitable distribution of the scarce water to the tens of thousands of poor farmers who would otherwise be without water. This simple and powerful paradigm has an inordinate appeal to engineers, civil servants and politicians.

65. After thirty years of continuously accumulating evidence that the centrally controlled, fully-gated, gravity canal schemes are not working as designed, they continue to be viewed as the only way to do business in Thailand. Privately, most irrigation engineers in Thailand admit that almost none of the constant head orifice structures have ever been used to measure flows as part of an overall water allocation plan. Yet, in the case of the Pattani scheme, where the Right Bank experience has been little short of disastrous, the Left Bank design is proceeding with the constant head orifice as the main tertiary control structure. The engineers explain this apparently irrational action on the grounds that "someday" it may be possible and desirable to measure water flows and the facilities to do so will then be in place. In the mean time; the flow measuring devices, which have not been broken by the farmers, are merely

used as costly gates in the "on" or "off" mode; farmers perforate the canal banks with pipes for water on demand; and inexperienced gate operators respond to farmer pressures. Reality bears little resemblance to the paradigm and a form of populist anarchy reigns.

66. The most common reaction to this charge is that of the engineers designing the Pattani Left Bank system. There is nothing inherently wrong with the idea of public, centrally controlled, fully-gated gravity canal systems employing CHO control structures. It only needs attention to good design, construction, maintenance, management and time for farmer education. Eventually things will come right.

67. For those who accept the local and international empirical evidence that the systems are, for very good reasons, operating under a regime substantially different from design intentions; many interesting possibilities present themselves. The most obvious thing to do is to examine how the existing systems actually operate and how the farmers interact with the system and its operators. In a country as large and varied as Thailand with a strong commercial ethic there are bound to be numerous "successes" in which public systems have been modified by the farmers to actually produce the services some farmers want and need. The pilot sugar technology mentioned above in the Mae Klong is only one example. A careful study of the wide-spread on-demand pumping from canals, its extent, and the means of distributing the water once it is removed would be another obvious area to investigate. It serves no purpose to ignore this reality and it may be something that should be encouraged. A study of farmer damage to control structures is also an obvious need. Berkhoff has shown that such damage in a wet season drought is entirely rational. 53/ It serves no useful purpose to ignore this rent-seeking reality since it creates much of the maintenance problem in the country.

68. The problem with pursuing such questions and documenting how things really work and why is that it raises the question of "what is to be done". The answer to this question is by no means obvious.

69. One engineering approach is to recognize the hydraulic instability of upstream controlled systems with up to a thousand manually operated, frequently undershot, gates and admit that such a system cannot be made to deliver the services required. Modern automatic down stream control structures and other real time feedback and control mechanisms together with the judicious use of buffer storage and overshot and undershot control structures can remove this essentially technical objection, certainly in the arid areas of the world where wet season rainfall is too little to support crop growth 54/ This is the group that calls for "modernization". In Thailand, and other tropical rice-growing countries with a substantial wet season, we do not yet know if such modern


systems can be made to work in public schemes with tens of thousands of small farmers all exhibiting rent-seeking behavior. Small farmer damage to hydraulically stable, modern, fully-gated systems operating in the tropics during a wet season drought is just as imminent as it is with the, manually operated, hydraulically unstable, fully-gated systems in use today.

70. One recent proposal to deal with the problem of wet season drought and resulting farmer damage in the tropics is the so called "structured" approach to irrigation system design and operation. The idea here is to sacrifice theoretical water use efficiency by simplifying and reducing drastically the number of gated outlets. Instead of trying to control and operate a thousand gates in a 100,000 ha. scheme, this approach would reduce the number to something like thirty key structures which are few enough in number and located such that they can be protected from farmer damage. With these key structures either on or off, a particular canal would either be flowing full or empty. Ungated outlets would take off from the full canals. Farmers would have no incentive to block canals running full and there would be no gates to damage or manipulate. The great virtue of this system is that it takes into account explicitly rent-seeking behavior and the tremendous potential for farmer damage to canals running only partially full, especially in a wet season drought. It recognizes that in a normal wet season very little irrigation may be needed at all while in a wet season drought all farmers will seek to protect their standing crops by taking water from the system simultaneously. Rather than destroy the infrastructure, better to sacrifice some standing crops in an equitable and planned manner by closing off certain canals at the key structure level. The evidence in Eastern India, where wet-season rainfall is usually high, is that the "structured" Bhakra system is much more manageable than the fully-gated Gandak system which has suffered severe farmer damage. The question of whose crops are to be equitably sacrificed in a wet season drought is the unresolved issue with this proposal.

71. Engineers with successful experience in the design and operation of modern, fully-gated, hydraulically stable irrigation systems tend to see the solution of the "Thai irrigation problem" as one of modernization and increasing sophistication and complexity to make the systems deliver their intended services. Engineers with experience with large public systems in areas with high rainfall wet seasons, like much of monsoon Asia and Central and Southern Thailand, tend to see the solution as one of decreasing hydraulic sophistication and increasing concern for control and protection.

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of the infrastructure from farmer damage and intervention. The latter group have clearly gone beyond the irrigation paradigm. 57/

72. **Economists** point out that any system paid for by user charges and under the control of the farmers tends to perform well. The economists push the notion of water user charges and financially self-sufficient parastatal operators so that farmers get water by paying what it is worth rather than trying to control the bureaucracy that allocates water or modifying the physical infrastructure. A pricing system harmonizes interests and sets unambiguous rules. For economists part of the solution to the "Thai irrigation problem" is to make the RID budget dependent on water user charge revenues, just as the state power company and the state railways are largely dependent on revenues from users. Experience in the Philippines has shown the dramatic change in attitudes of the irrigation bureaucracy when the incentives facing the management and farmers shift to quasi commercial standards. 58/

73. Still another group of professionals see a different route to addressing the problem. These are the rural **sociologists** that approach the operation of an irrigation scheme not as a complex problem of the hydraulics of open channel flow. Rather they see it as an exercise in cooperative group dynamics in which social engineering is at least as important as hydraulics. Rent-seeking behavior can be controlled if the social institutions can be brought to bear on the problem. They point to the successful irrigation associations in Bali, Taiwan and Japan as proof that rent-seeking behavior need not break out in public irrigation schemes. They usually embrace the notion of the economists that the financial participation of the farmer in the construction and operation of the scheme is an essential ingredient of success. Engineers have no quarrel with the position of the sociologists concerning water user groups and generally wish them well, occasionally citing the failure to form effective groups as being the reason their infrastructure is not being used as designed. The sociologists are the people most qualified to address the effect of part-time farming on the use of public irrigation systems. Neither the economists nor the engineers are equipped to address these sorts of questions.

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57/ The Region objects to the bifurcation of engineering approaches to irrigation system design and operation into the "modern" and the "structured" schools. They emphasize that there are more areas of agreement between the two groups than disagreement. The principal area of agreement is the desirability of a technology for effecting hydraulic stability. The principal area of disagreement may be in the level of "structuring" or the size of the area to be served by the lowest gate in the control structure hierarchy.

Conclusions

74. In retrospect, RID's and the Bank's early approach to irrigation development could be characterized as an unconscious variant of the "structured" approach to system design. First, spread the water with diversion structures and a primary and secondary canal system. Gated tertiaries and on-farm development would not be included. Then, provide dry season storage to firm up wet season flows and provide for some dry-season cropping. If this had been combined with an attractive farm-gate price for rice in the mid 1960s by a sympathetic Ministry of Commerce, then success could have been declared as the rice would certainly have been forthcoming, given the reservoir storage, the low-lift pump technology and the supply elasticities.

75. The fact that twenty-five percent of the Mae Klong Left Bank service area was already irrigating in the 1980 dry season with low lift pumps before Irrigation XII is some indication that the early "water spreading" approach was both effective and appropriate for Thai macro economic objectives. The subsequent fact that paddy farmers owning 38 percent of the Mae Klong service area did not want the tertiary system provided under Irrigation XI and XII is another indication that they had worked out their own solution to final delivery of water since the cropping intensity in the area is approaching 190 percent. The Bank's role as a supporter of the irrigation subsector could have ended a good deal earlier in an environment of conspicuous success.

76. Instead farm-gate prices were kept low until 1972 and farmers were not responding well to the provision of free infrastructure and water. The explanation for the lack of intensification during the pre 1972 period revolved around engineering questions of water delivery. On-farm development and land consolidation was what was needed to get the farmers to use the water. There were no calls for the reduction of the effective export tax to raise incentives to produce rice commercially and achieve the benefits the earlier investments were designed to produce. The decision was to give more and better gated infrastructure to irrigated rice farmers. In the Chao Phya Basin this strategy finally encountered the overall water constraint of the basin.

77. In the Mae Klong the problem of too much investment for the water available was avoided. However, the gated technology chosen in the final projects was not, in retrospect, appropriate for the relatively high wet season rainfall conditions nor for the rent-seeking environment created by a free water policy. Going for high-command extensively-gated systems was, in retrospect, a questionable decision since this form of modernization and upgrading did not take account of what was actually happening and what could work in the Thai context. A much less costly extension of the "spreading" infrastructure without the gates and without the high canals on fill would have extended irrigation potential (similar to that already incorporated on twenty-five percent of the pre project area) to the bulk of the farm population without the uneconomic capital costs. The reluctance of many farmers in the Mae Klong to "accept" the on-farm development that would allow them to benefit from this command should not be attributed to simple ignorance. The sugar farmer response in the same area is proof that a price is paid for command technology. The
sugar growers preferred to allow the water to drop a meter or so from the offtake into ditches for later low-lift pump delivery rather than exploit the FSL elevation. For crops requiring different amounts and timing of water this system makes a lot of sense. It is a major break with the standard rice irrigation technology and fits much more the needs of a diversified cropping picture.

78. The major contribution of the Thai farmer to public tropical irrigation systems is their demonstrated willingness to pump water the final meter or so to their crops. A privately owned final delivery system incorporated into a public, "structured", largely gateless canal system with FSL at or below ground level is an intriguing concept. It fits with the, by now, indisputable Thai policy of free canal water and a large centralized canal bureaucracy. It fits the wet season rainfall conditions of the south and the central plain and it squares with what the farmers are actually doing. If concern with reality could ever overcome the powerful attraction of the irrigation paradigm, it is quite likely that Thai engineers could then encourage the development of an appropriately Thai irrigation technology that would not have to be patterned after what worked for special reasons in Japan, California, North Africa or colonial Indonesia. The elements of such a technology are already emerging. It takes official recognition of what already exists to make these initiatives technically respectable. The rest of humid, rice-growing, tropical Asia would then have a model to look towards that might help them with their own divergences between design and reality. 60/

59/ This is, in fact, being done in the Songkla Lake scheme in the South. This Australian-designed system is to lead water from Songkla Lake through low level canals to the farmers fields. The final delivery of water to the crops will be by privately owned low lift pumps. The major anxiety of the engineers is what will happen if the farmers don't take the water. To the economist it would mean that the provision of the water is not worth much and that the economics of the scheme is suspect. Such market tests are useful for public schemes and serve to focus the engineer's attention on the primary purpose for which the scheme is designed.

60/ The Region shares the Audit's view that the low-lift pump delivery system is likely to be appropriate in delta areas such as the Lower Chao Phya. The Region takes exception with the Audit concerning the potential for low-lift pump technology beyond the delta areas. They feel that any place where water can be delivered to command the surrounding terrain should not have a system requiring external energy at the farm level for final delivery of water. If pumping is to be promoted it should be a more efficient central pumping station technology delivering water into a communal gravity canal such as those used successfully in Japan, Korea, China and the northern parts of Vietnam. If the Audit is to promote such an unorthodox technology there is a burden of economic proof that remains to be made for it.
Caveats

79. There are two major concerns the Audit has with the line of reasoning set forth above. The first is the danger of simplification and overstatement in order to make a point. The fact that there are probably over a million low-lift pumps operating in the country today and that Thai farmers are willing to use this technology in conjunction with public irrigation schemes to give them the flexibility they need to produce a range of crops is an attractive development for those interested in agricultural production and crop diversification. Seizing on this possibility as a panacea is the danger. There is no magic in this development. It already exists where it makes sense and it only needs to be officially recognized by the engineering profession and documented. Most public irrigation schemes in Thailand have already been modified by influential and well-located farmers to give them what they need. Some of these modifications, principally the permanent pipe installations in the canal banks, clearly require the active or passive cooperation of the canal bureaucracy.

80. The second concern is the equity issue. One of the most attractive features of the official engineering designs is that every farmer in the command area, in theory, gets his fair share of the available water. The fact that, in reality, upstream users and those close to the primary and secondary canals get much more than their fair share at the right time is indisputable. The Golongan system of rotation has not worked in Thailand any better than it has in Indonesia. If one accepts the inherent and inescapable inequity of the present system of populist anarchy, then the jump to a demand-oriented first-pump-first-served system that is, even in theory, inequitable is less difficult to contemplate. It is, in the Audit’s opinion, likely that accepting this inequity will allow the designers to produce a system that is both more efficient and less

61/ The line of argument ignores the larger equity issue of rain-fed rice farmers who receive no water control versus the fortunate ones who receive free canal water.

inequitable than that which exists at present. 63/ This is something that would have to be studied carefully. For those who insist that the existing systems can be made to work according to the original equitable designs, the contemplation of something that is admittedly inequitable at the outset is a step backward. The problem with the theoretical position is that all the empirical evidence is against it. It then becomes a hopeful assertion rather than a realistic assessment of what is possible.

81. In most countries the pressure of events in the form of food shortages or public sector budget constraints eventually forces irrigation system designers to contemplate reality. This has already happened in Bangladesh where the imperative of foodgrain production has forced the planners to accept an indisputably effective low-lift pump and shallow tube well technology despite the opposition of strong centralized bureaucracies in charge of competing technologies. 64/ In Indonesia, a public sector resource constraint has put pressure on the irrigation subsidy to the point where the public provision of tertiary infrastructure has been abandoned and the smaller public schemes are to be turned over to the farmers for both operation and maintenance. 65/ In Japan the major force for change in the present system is the aging farm population and the unwillingness of young people to grow irrigated rice at any price. 66/

82. In Thailand none of these forces is operating and the only signal that something may be wrong is the low economic returns to large scale irrigation investments including the two under audit. This by itself is unlikely to effect any changes. The only near-term inescapable physical reality in Thailand that cannot be ignored is the increasing scarcity of surface water resources for agriculture and urban industrial and domestic consumers. Even this pressure will not necessarily generate a real need to incorporate reality into the design of future irrigation system investments as long as inter-basin transfers are a technical possibility. Those who subscribe to and benefit from the theoretical irrigation paradigm can then

63/ Paradoxically, very little water in Thailand is wasted in a basin sense even though the individual irrigation schemes have very poor efficiency ratings, usually in the order of thirty percent. Should upstream systems become efficient it could be to the detriment of down-stream users who have come to depend on upstream inefficiencies for their water. The rice farmers in the lower Chao Phya Basin, who in the late 1960s began using dry season releases from the two storage dams by pumping from drains, would be the first to be hurt by efficient upstream use of the, now scarce, dry season flows in the Chao Phya.


continue to overlook what is actually happening and exclude it from their calculations. The farmers can then go ahead and modify these systems to suit their purposes. It is a costly way to do business but it may, as in the Japanese case with rice subsidies, be a price the country is willing to pay.
Annex 1: An Alternative View of Historical Development 1/

1. There was a surge in construction in the late 1960s and the works built by the Royal Irrigation Department (RID) had many shortcomings. The Survey Division was very weak in those days (it was greatly improved in the 1970s under an IDA credit) and the maps it produced often contained gross errors. As a result, some main canals and laterals were too low to command the lands they had been built to irrigate. Mains and laterals were routinely lined with concrete, even though many of them passed through heavy impermeable soils where an unlined canal would have been much cheaper and easier to modify in the future. There were also not enough laterals and this created problems for the planning and design of tertiaries. In many projects, the main systems were built years ahead of any attempt to build tertiaries, and it was not uncommon for sections of a main canal to be left unfinished because of construction problems or difficulties in land acquisition. Finally, there were often too few control structures and outlets in the mains and laterals. The position of RID was that the farmers would complete the systems needed to bring water to their fields. In the Northern Chao Phya, the deficiencies in the main systems were not so pronounced but, as in other RID projects, the density of laterals was too low; fortunately the mains and laterals were generally high enough to command the land and there was no unnecessary concrete lining.

2. The Mae Klong Project had all of the problems cited above, and this situation was to some extent of the Bank's own making. The 1965 loan was only for construction equipment. At appraisal and during supervision there was no quality control of mapping, planning, design or construction. While the project was being built there was a boom in sugar and most of the higher flood-free land was turned over to sugar cane. Unfortunately most of this higher land was out of command because of errors in mapping. Most of the sugar is rainfed but sugar farmers pump from the canals to irrigate their crop. Irrigation XI and XII, except for a small component for Pattani, aimed at correcting deficiencies in the mains and laterals at Mae Klong and to provide the works needed to get water to the farmers' fields, generally referred to as on-farm development (OFD). The sugar areas were excluded from the lands to be served by OFD since there was no way to bring them into command. Also, the low-lying flooded areas remote from the main system were excluded because of the risk of flood damage and because there were already served by low-lift pumps from the long-established drainage canals.

3. The most difficult and controversial problem faced in Thailand's irrigation sector since the late 1960s has been how to get water from the main and laterals to the farmers' fields. The first Bank initiative was a Bank loan in 1965 for what came to be known as the "Ditches and Dikes" Project in the Northern Chao Phya. This is the simplest form of OFD and consists of tertiary canals at about 400 m spacing radiating out from the mains and laterals. No tertiary drains are provided and usually there are

1/ This Annex is based on the written comments by a staff member engineer who worked for many years on the Thai irrigation lending program. Its inclusion without comment by the Audit does not imply acceptance or endorsement of the views expressed.
no roads along the tertiaries. They are also sized for continuous irrigation and hence are smaller than if designed for rotational irrigation. The main shortcoming is that the tail of the ditch gets less water than the head; the result is that the irrigation tends to be limited to a strip several kilometers wide on each side of a main or lateral canal. This would not be too much of a problem if there were enough laterals.

4. Surprisingly, the "Ditches and Dikes" worked quite well and by 1975 some of the project areas in the Northern Chao Phya had quite high cropping intensities. There was, however, some reluctance to accept this in the Bank because strong support developed for the higher standards of OFD pioneered by the Netherlands in the Northern Chao Phya. This type of OFD provides a more or less rectangular grid of ditches and drains through land levelling and rearrangement of farm boundaries (often referred to as land consolidation). This approach was, in fact, quite successful and the survey, design and construction techniques developed in Thailand were far in advance of many other countries. Unfortunately, it never had the full backing of RID's management. Furthermore, it placed heavy demands on a scarce resource - RID staff with the skills and dedication needed to negotiate with farmers and gain their confidence. This mode of development reached its peak at a time when it was finally acknowledged in Thailand and the Bank that all the dry season water in the Chao Phya Basin was being used. Thus, the extra water needed to reach high second-crop intensities and justify the investments in land consolidation had a high opportunity cost.

5. Another form of OFD in the Chao Phya made its appearance on a large scale beginning in 1972. This consists of low-lift pumping from the long-established navigation/drainage canals of the Southern Chao Phya. Typically, each farmer digs a ditch to his land and operates his own pump. Several factors spurred this type of irrigation. The Sirikit and Bhumiphol reservoirs on the tributaries of the Chao Phya had changed the flood regime in the lower delta and large areas were deprived of the flood-dependent crop. Fortunately, the same reservoirs created a supply of dry-season water. These hydrologic changes also coincided with the availability of proven dry-season rice varieties.

6. For Mae Klong, the targets for OFD were 66,000 ha on the Right Bank for Irrigation XI and 27,000 ha on the Left Bank for Irrigation XII. By the time the loans were closed, the areas provided with OFD were 38,000 ha on the Right Bank and 22,000 ha on the Left Bank. Despite the shortfall on the Right Bank, this was still a considerable accomplishment. Prior to the project the areas provided with OFD grew a single crop of rainfed rice. Within three years following OFD completion, virtually all of the area served was double cropped with irrigated rice. The project pioneered a new type of OFD - a simplified version of the intensive form adopted in parts of the Northern Chao Phya. It does not include land consolidation or land levelling and, as far as possible, the ditches and drains follow the farm boundaries to reduce infringement on the farmers' land. Unfortunately, this requires more negotiation than the intensive but more costly approach.
THAILAND

ELEVENTH IRRIGATION PROJECT (LOAN 1781-TH)

PROJECT COMPLETION REPORT

Overview

General

1. The Eleventh Irrigation Project comprised two completely separate subprojects: the Mae Klong Right Bank (MKRB) subproject in Central Thailand and the Pattani subproject in Southern Thailand. This Overview is therefore based on two Project Completion Reports (PCRs)—the PCR for the MKRB subproject, prepared by International Land Development Consultants (ILACO) in association with Empire M&T Co. Ltd., and the PCR for the Pattani subproject, prepared by the Royal Irrigation Department (RID) of the Ministry of Agriculture and Cooperatives (MOAC) of Thailand. The Overview also draws on the Loan Agreement, the Bank's Appraisal Report, supervision mission reports, correspondence with the Borrower, and internal memoranda in Bank files.

Background

2. Through the 1960s, Bank support for irrigation development in Thailand had centered on the Chao Phya Basin because of its economic potential. Subsequently, the Bank extended its support to other areas, in an effort to promote rural development and poverty alleviation. The development of the Mae Klong Basin was given high priority. Under a 1963 comprehensive plan, RID had decided to develop the region in two main stages: the Mae Klong left bank area (eventually financed by the Bank under Ln. 2022 in 1980) and the Mae Klong right bank area. Development of the overall MKRB was initiated by RID in 1970 through a number of small development schemes. At the same time, RID was involved in a two-stage development of the Pattani River Basin in the south. Because the preparation period of the two coincided, at the Government's urging the Bank agreed to include both developments into a single project focused on rural poverty alleviation.

3. The Bank's prior experience with RID had been positive. Since 1950, the Bank had financed four multipurpose dams and nine irrigation projects, totalling US$446 million. Six of the projects were in the Chao Phya Basin, one in the Mae Klong Basin, two in the Northeast, and one in Petchaburi close to the Mae Klong Basin. The five projects undertaken by RID since 1973 incorporated higher standards of water control to fully exploit the Basin's irrigation potential.
The PPAR No. 2850 of February, 1980 for the Sirikit Dam (Loan 514-TH) indicates that the project was highly successful.

4. During identification, preparation and appraisal of the Eleventh Irrigation Project, many issues arose: the appropriateness of the inclusion of the Pattani component, RID's design capacity, institutional arrangements within RID for implementing the project, monitoring and evaluation, procurement procedures for civil works contracts, the adequacy of agricultural support services, and cost recovery. As it turns out, these issues have not been completely resolved during the implementation of the project.

**Project Objectives**

5. The Eleventh Irrigation Project was designed to improve and expand Thailand's irrigated paddy area by 66,000 ha along the right bank of the Mae Klong River in Central Thailand, and by 15,000 ha along the right main canal of the Pattani subproject in southern Thailand. About 30,400 farm families, or 200,000 people, were expected to benefit from increased agricultural production and incomes generated by: improvement, enlargement and completion of main canals, laterals and service roads; completion of main and secondary drains; on farm development (OFD); and improvements in system operations and maintenance (O&M). The project was also expected to generate demand for an additional 5.2 million man-days of labor per year. Finally, the project would provide technical assistance and training for the development of monitoring and evaluation (M&E) procedures, and would finance preparation of detailed designs for irrigation development of an additional 30,000 ha at Pattani.

**Project Content**

6. **Irrigation and Drainage Systems.** This component included the following main features:

   (a) **Mae Klong Right Bank**

   (i) improvement and enlargement of 157 km of existing main canals and completion of 33 km of new main canal;

   (ii) improvement and enlargement of 206 km of existing lateral canals and construction of 103 km of new lateral canals and service roads;

   (iii) completion of about 336 km of main and secondary drains; and

   (iv) on-farm development, including tertiary canals, drains and farm roads, for a total area of 66,000 ha;
(b) Pattani

(i) improvement of 23 km of the existing right main canal and construction of the remaining 25 km of that canal;

(ii) construction of about 134 km of laterals and service roads;

(iii) construction of about 165 km of main and secondary drains; and

(iv) on-farm development, including tertiary canals, drains and farm roads, for a total area of 15,000 ha.

7. Technical Assistance and Training. This component included:

(i) Monitoring and Evaluation: consultant services to assist RID in strengthening its M&E capability, including establishment of an in-house monitoring unit; strengthening of RID's Irrigated Agronomy Branch of the O&M Division (engaged in the routine collection of crop statistics for all irrigation projects) and the Economics Branch of the Planning Division (responsible for agroeconomic baseline surveys), and development of efficient M&E procedures to track irrigation projects benefits;

(ii) Water Management: technical assistance and training to establish efficient procedures for water management, so as to ensure timely and adequate deliveries of irrigation water; and

(iii) Detailed Designs: technical assistance for detailed design of a further 30,000 ha of irrigated area from the Pattani River.

Implementation

8. Organization and Management. Project implementation was the responsibility of the RID of MOAC. In order to overcome coordination problems which had occurred in the past caused by fragmentation of project activities among various divisions and offices, RID assigned a Project Manager for MKRB and one for Pattani with overall responsibility for all implementation aspects. The two managers reported to a Project Director who was one of RID's Deputy Director Generals.

9. Each Project Manager was responsible for coordination of all subproject activities performed by consultants, by other functional divisions within RID, and by other government agencies. Additionally, a Project Engineer was assigned to each subproject, coordinate field operations. Consultants (ILACO/EMPIRE M&T for the MKRB subproject and SVERDRUP & PARCEL/RESOURCES ENGINEERING for the Pattani subproject) assisted project management in design and construction supervision. At the Central level, many of RID's functional divisions (e.g. O&M Division, Project Planning Division, etc.), as well as several of MOAC's departments/offices were also involved in project implementation. The Department of Agricultural Extension (DAE) was responsible for providing agricultural advice
to farmers in both subprojects, and the Bank for Agriculture and Agricultural Cooperatives (BAAC) was responsible for collecting water charges.

10. **Construction of Irrigation and Drainage Systems.** The quality of civil works by contract at MKRB was generally acceptable. The quality and progress of OFD construction, mostly done by force account, was at first disappointing, but improved in later years. However, OFD never caught up with initial delays and at loan closing had reached only 56% of the appraisal target. At the Pattani subproject, neither quality nor the progress of construction was satisfactory. Most canal systems were left unfinished. For those parts designated 'completed' in the project report only the earthwork was done. Furthermore, as a result of farmers' opposition to OFD works, only 29% of the target area had been developed at loan closing. Farmers' opposition to OFD was due to (i) lack of compensation for rights-of-way for OFD; (ii) lack of access to water by some farmers; and (iii) failure by RID to demonstrate irrigation benefits and to generate broad community support.

11. The physical achievements vs. appraisal targets for the project are summarized in Table 1 on the next page. It was anticipated at appraisal that the project would be completed in five years (i.e. by December 31, 1985) and that the loan would be closed on June 30, 1986. During the course of implementation, the Loan Closing Date was extended twice, the last time - to June 30, 1988, and neither subproject was fully completed. Disbursements continued until March 31, 1989 (on special permission from the Bank's Regional Vice President, because of exceptional flooding in November 1988 in the Pattani area). The longer than expected implementation period for the two subprojects was due mainly to the following factors.

(a) **At Mae Klong Right Bank:** (i) Initial delays in engaging consultants; (ii) time required for redesign of OFD in view of RID's disagreements with consultants on initial design criteria; (iii) cumbersome and lengthy procurement procedures; (iv) inadequate condition of force account plant and equipment; (v) insufficient and untimely funding; (vi) inability to work during most of the 1986 wet season; and (vii) repeated and protracted negotiations with farmers on rights-of-way acquisition for on farm ditches and drains;

(b) **At Pattani:** (i) Initial delay in engaging consultants; (ii) time required for additional topographic surveys because of noted inaccuracies in original plans; (iii) time required for redesign of OFD in view of disagreements with consultants on initial designs; (iv) delays caused by additional work of lining the head-reach of the main canal; (v) time lost in disputes with the main civil works contractor concerning pay items (overhaul) and quantities; (vi) farmers initial opposition to OFD; (vii) longer than normal rainy periods (1986, 1987) which reduced construction time; and (viii) damage from major floods in early December of 1987 and November of 1988. The detailed design for a further 30,000 ha in the Pattani River area was not carried out under this project.
### Table 1: PHYSICAL ACHIEVEMENTS VS. APPRAISAL TARGETS

<table>
<thead>
<tr>
<th>Project Features</th>
<th>Appraised Target</th>
<th>Actual Achievements</th>
<th>Actual as Percentage of Appraised</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mae Klong Right Bank (as of 1987)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a) Improvement and Enlargement of the existing main canal</td>
<td>157 km</td>
<td>157 km</td>
<td>100%</td>
</tr>
<tr>
<td>(b) Completion of new main canal</td>
<td>33 km</td>
<td>33 km</td>
<td>100%</td>
</tr>
<tr>
<td>(c) Improvement and Enlargement of existing lateral canals</td>
<td>206 km</td>
<td>282 km</td>
<td>137%</td>
</tr>
<tr>
<td>(d) Construction of new lateral canals and service roads</td>
<td>103 km</td>
<td>78 km</td>
<td>76%</td>
</tr>
<tr>
<td>(e) Completion of main and secondary drains</td>
<td>336 km</td>
<td>582 km</td>
<td>173%</td>
</tr>
<tr>
<td>(f) Irrigable Area with OFD works (tertiary canals, drains and farm roads) construction</td>
<td>66,000 ha</td>
<td>37,700 ha</td>
<td>57%</td>
</tr>
<tr>
<td><strong>Pattani (as of 1988)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a) Improvement of the existing right main canal</td>
<td>23 km</td>
<td>15.3 km$^1$</td>
<td>67%</td>
</tr>
<tr>
<td>New Construction of the right main canal</td>
<td>25 km</td>
<td>10.6 km$^1$</td>
<td>42%</td>
</tr>
<tr>
<td>(b) Construction of laterals and service roads</td>
<td>134 km</td>
<td>125.7 km$^1$</td>
<td>94%</td>
</tr>
<tr>
<td>(c) Construction of main and secondary drains</td>
<td>165 km</td>
<td>61.3 km</td>
<td>37%</td>
</tr>
<tr>
<td>(d) Area with OFD construction including tertiary canals, drain and farm roads</td>
<td>15,000 ha</td>
<td>4,288 ha</td>
<td>29%</td>
</tr>
</tbody>
</table>

1/ Structures were not completed.
12. Monitoring and Evaluation. After RID accepted and approved the consultants' proposal, a special Project Monitoring and Evaluation Unit (MEU) was set up within the Economics Branch of RID's Planning Division. MEU, with assistance from consultants, was responsible for all monitoring activities--concentrating primarily on agricultural progress and project benefits, particularly OFD activities. Impact or ex-post evaluation of the project was the responsibility of the Office of Agricultural Economics of the MOAC. RID was responsible for ongoing monitoring of the project during implementation. For these purposes, RID carried out an intensive baseline survey in January/February 1982 to generate reference data.

13. The regular collection of data for project monitoring was particularly useful. Regular surveys of agricultural developments and benefits of this subproject started in 1987 in areas where OFD works had been completed, and agricultural production data were collected and used in deriving estimates of project benefits.

14. Water Management. RID improved its operational capability through the introduction of computerized water scheduling and monitoring at MKRB. By developing appropriate software, the Consultant prepared daily/weekly delivery schedules (WASAM) for mains and laterals of the irrigation system, based on projected climatic conditions, consumptive use requirements, and computerized monitoring of programmed schedules was introduced and results discussed by the O&M staff of each Zone. This represented a breakthrough in RID's attempts to match water supplies with demands.

15. The Consultant also helped RID to introduce a computerized, automated maintenance planning process (AMPP) for MKRB. This program enabled RID's O&M staff first to review critically all various maintenance activities, classify them in accordance with the frequencies required to sustain system performance, and finally plan activities in proper sequence and frequency.

Project Costs and Disbursements

16. The appraised cost of the project was US$186.0 million (MKRB US$137.0 million, Pattani US$49.0 million) and the loan was US$80.0 million (MKRB US$61.0 million, Pattani US$19.0 million). By loan closing (June 90, 1988) the actual total project cost was US$171.0 million, with total disbursements of US$54.4 million. Loan disbursements had commenced during the second project year (IBRD FY81), but continuously lagged behind the appraised disbursement schedule by 30-60%. The Bank cancelled parts of the loan on three occasions (US$1.8.0 million on June 17, 1987; US$6.5 million on July 7, 1988; US$1.1 million on January 10, 1989).

17. Mae Klong Right Bank. The total appraised cost for the MKRB subproject was US$137.0 million, with US$61.0 million of the loan allocated to this subproject. By loan closing the actual cost of work completed was US$137.1
million\textsuperscript{1}, with total disbursements of US$41.6 million. However, it is important to remember that the subproject was not completed at the appraised scope.

18. The cost of OFD work increased from US$550/ha at appraisal to US$750/ha at project completion because of the inclusion of feeder ditches across some service units; the lining of a number of on-farm ditches; and the unanticipated cost of overhead. Construction costs also rose because of increases in the length of canals and drains. Nonetheless, final total costs were lower than appraisal estimates because of the reduction in area from 66,000 ha at appraisal to 44,500 ha and the fact that considerably less OFD work was implemented. Bank disbursements were also lower than appraisal estimates because a larger portion of civil works were carried out by force account under RTG's budget than by contracts under the Loan.

19. Pattani. The total cost of the Pattani subproject was estimated at US$49.0 million at appraisal, with US$19.0 million of the loan allocated to this subproject. Because of lack of progress in the construction of the irrigation system, RID repeatedly reduced the scope of work at Pattani. Consequently, parts of the loan were cancelled on two occasions (US$3.0 million on June 17, 1987; US$3.2 million on July 7, 1988). By loan closing the actual cost of the subproject was Baht 821.6 million or US$33.9 million, with total loan disbursements of US$12.8 million.

Agricultural Production

20. Mae Klong Right Bank. The main crop in the MKRB subproject was rice. The second crop was sugarcane, which covered 9% of the cropped area at the start of the project in 1979 and has retained about the same share until 1987. As indicated in Table 2 below, in 1987, of the 37,700 ha on which OFD facilities had been provided, 28,700 were irrigated. The irrigated area is expected to increase at full development in 1994 to 44,500 ha (PCR Table 2.2). With an abundant water supply, dry-season cropping kept pace with OFD, and the cropping intensity for the paddy area increased dramatically from 105% at appraisal to 195% in 1987. It is expected to remain equally high at full development (cf. appraisal target 190%). Yields are also expected to approximate appraisal estimates.\textsuperscript{2} Local irrigated wet season rice, 2.5 ton/ha at appraisal, was 3.0 ton/ha in 1987 and is expected to reach 3.2 ton/ha at full development (cf. appraisal target 3.5 ton/ha). The yield of HYV wet season rice, which was introduced with the project, was 3.6 ton/ha in 1987 and is expected to reach 4.1 ton/ha at full development (cf. appraisal target 4.0 ton/ha). The yield of HYV dry season irrigated rice increased from 3.0 ton/ha at appraisal to 3.7 ton/ha in 1987 and is expected to increase to 4.4 ton/ha at full development (cf. appraisal target 4.2 ton/ha). The yield of sugar, recorded at appraisal as 55.0 ton/ha, had increased to 80.0 ton/ha in 1987 and is expected to reach the 90.0 ton/ha at full development.

\footnotesize{\textsuperscript{1} MKRB's PCR calculated this figure to be US$125.0 million using a 1988 conversion rate (Table 2.6, p. 27). In this Overview the prevailing exchange rates were used (US$1 = Baht 20 from 1980-1983 and US$1 = Baht 25 from 1984-1989).}

\footnotesize{\textsuperscript{2} Yield figures for 1987 are based on averages of actual data obtained from a Baseline survey and project benefit monitoring surveys; yield figures for 1988 and beyond are projections.}
Table 2: KEY PRODUCTION DATA FOR THE MKRB SUBPROJECT

<table>
<thead>
<tr>
<th></th>
<th>1979</th>
<th>1987</th>
<th>Anticipated at Full Dev.</th>
<th>Appraisal Estimated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area with OFD (ha)</td>
<td></td>
<td>37,700</td>
<td>44,500</td>
<td>66,000</td>
</tr>
<tr>
<td>Irrigable Area from OFD (ha)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wet Season Rice</td>
<td></td>
<td>31,700</td>
<td>44,500</td>
<td>66,000</td>
</tr>
<tr>
<td>Dry Season Rice</td>
<td></td>
<td>28,700</td>
<td>44,500</td>
<td>66,000</td>
</tr>
<tr>
<td>Yields (ton/ha)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Local irrigated wet season rice</td>
<td></td>
<td>2.5</td>
<td>3.0</td>
<td>3.2</td>
</tr>
<tr>
<td>HYV wet season rice</td>
<td></td>
<td>3.6</td>
<td>4.1</td>
<td>4.0</td>
</tr>
<tr>
<td>HYV dry season rice</td>
<td></td>
<td>3.0</td>
<td>3.7</td>
<td>4.4</td>
</tr>
<tr>
<td>Sugar, irrigated</td>
<td></td>
<td>55.0</td>
<td>80.0</td>
<td>90.0</td>
</tr>
<tr>
<td>Paddy Cropping Intensity (%)</td>
<td></td>
<td>105.0</td>
<td>195.0</td>
<td>195.0</td>
</tr>
</tbody>
</table>

21. Pattani. As summarized in Table 3 below, in 1988 the irrigated area at Pattani included 4,288 ha with, and 3,184 ha without, OFD facilities.1 Cropping intensity had increased from 100% at appraisal to 107%, and is expected ultimately to reach 150% at full development, somewhat less than the appraisal target of 170% (PCR Table 5.1, p. 29). The yield of local irrigated wet season rice was about 2.0 ton/ha in 19882 and is expected to increase at full development to 2.7 ton/ha (cf. appraisal target 2.5 ton/ha). The yield of HYV wet season rice, introduced under the project, was 2.3 ton/ha in 1988 and is expected to increase at full development to 3.3 ton/ha (cf. appraisal target 3.0 ton/ha). The yield of HYV dry season rice, also introduced under the project, was 3.3 ton/ha in 1988 and is expected to increase to 3.5 ton/ha at full development (cf. appraisal target 3.5 ton/ha).

1 By 1988 OFD covered only 4,288 ha of a total area of 6,160 ha of the developed part of Zone A1 by main and secondary systems. During the 1988 wet season the total irrigated area was reported as 7,472 ha, which included 1,312 ha in Zone A2 (without OFD).

2 Yield figures for wet (1987) and dry (1988) season are based on RID Agro-economic Survey (1988); yield figures for 1989 and beyond are recent projections by RID.
Table 3: KEY PRODUCTION DATA FOR THE PATTANI (RMC) SUBPROJECT

<table>
<thead>
<tr>
<th></th>
<th>1979</th>
<th>1988</th>
<th>Anticipated at Full Dev.</th>
<th>Appraisal Estimated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area with OFD (ha)</td>
<td>-</td>
<td>{4,288}</td>
<td>4,928</td>
<td>15,000</td>
</tr>
<tr>
<td>Area w/o OFD (ha)</td>
<td>{3,184}</td>
<td>8,636</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subtotal</td>
<td>7,472</td>
<td>13,564</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Irrigable Area (ha)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(with and w/o (ha) OFD</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wet Season Rice</td>
<td>-</td>
<td>7,472</td>
<td>13,564</td>
<td>15,000</td>
</tr>
<tr>
<td>Dry Season Rice</td>
<td>-</td>
<td>491</td>
<td>6,800</td>
<td>10,000</td>
</tr>
<tr>
<td>Yields (ton/ha)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Local irrigated wet season rice</td>
<td>-</td>
<td>2.0</td>
<td>2.7</td>
<td>2.5</td>
</tr>
<tr>
<td>HYV wet season rice</td>
<td>-</td>
<td>2.3</td>
<td>3.3</td>
<td>3.0</td>
</tr>
<tr>
<td>HYV dry season rice</td>
<td>-</td>
<td>3.3</td>
<td>3.5</td>
<td>3.5</td>
</tr>
<tr>
<td>Sugar, irrigated</td>
<td>55.0</td>
<td>80.0</td>
<td>90.0</td>
<td>90.0</td>
</tr>
<tr>
<td>Paddy Cropping Intensity (%)</td>
<td>106</td>
<td>150</td>
<td>170</td>
<td></td>
</tr>
</tbody>
</table>

Project Impact

22. **Mae Klong Right Bank.** The major impact of the project was an increase in the production of rice (wet and dry season) and sugar (Table 4.13, PCR), and consequently also of farm incomes. This was achieved primarily by an increase in the dry season cropped area and secondly by higher yields. At full development, the difference between the pre-project and post-project annual farm income is expected to be approximately US$164/ha at the current exchange rate (Table 5.1, PCR). The demand for labor also increased between 1984 and 1987 by 12.5 workdays/ha. Wages increased from $25/day at appraisal to an average of $38/day in 1987, in normal terms, but did not increase in real terms.

23. The ERR for the MKRB subproject was appraised as 35% based on the 1979 commodity price forecasts and appraisal data. In 1987, the Consultant re-assessed the ERR for RID at 15.4%, based on actual project implementation data and the Bank's Fall 1987 commodity price forecasts. Subproject economic viability appeared fairly robust and was expected to remain so despite the delays in start-up and in benefit generation. Although this analysis was correct, using the Bank's more recent September 1988 commodity price forecasts, the re-estimated ERR would be only 8.2%. 
The ERR for the Pattani subproject was appraised as 23%. In 1988 the Borrower reassessed the ERR as 4.9%, based on 1987 prices and 7.2% based on 1989 prices and a 30-year project life. It should be noted that these figures assume that peak output will be attained in 1993 (in Zone A1) and in 1996 (in Zone A2), which is probably optimistic.

Bank and Borrower Performance

25. The performance of the Bank concerning MKRB was satisfactory in appraisal and supervision of the physical features of the subproject, but insufficient attention was given to potential beneficiaries who were reluctant to cooperate with project authorities to one degree or another. The implementation schedule was also overly optimistic; given its prior involvement with RID, the Bank should have appreciated the fact that the agency's rather cumbersome and lengthy procurement procedures would require significantly more time at each stage of implementation. In the case of Pattani, the Bank did not sufficiently recognize at appraisal the local political and ethnic environment which made it especially difficult for RID to obtain farmer cooperation, at least during initial years.

26. The agreement with RTG on the recovery of O&M costs from beneficiaries (Loan Agreement Section 4.04) called for (i) submission to the Bank by June 30, 1981 of a proposal for the establishment of appropriate O&M cost recovery levels and collection procedures; (ii) collection of agreed upon rates from users within one year of the completion of tertiary works in blocks of (about) 1,000 ha; (iii) a study by June 30, 1984 of capital cost recovery; (iv) proposals by December 31, 1984 for recovering capital costs through appropriate fees; and (v) after completing tertiary works in blocks of (about) 3,000 ha recovery of a reasonable portion of capital costs on terms and procedures acceptable to the Bank. This agreement has not been complied with and although it should have been addressed by supervision mission, probably because O&M costs were not recovered in other Bank-funded agricultural operations in Thailand as well, it was not addressed here.

Lessons Learned

27. Potential beneficiaries of irrigation projects should be actively involved in decision-making during all phases of the project. Ideally, such involvement should start at least one year before plans of new (or rehabilitated) systems are finalized, or at least during the planning stage. Water user associations (based on hydrologic or tertiary borders) should be established early on, and their training provided. Experience elsewhere in Southeast Asia (e.g. Philippines and Indonesia) suggests that this activity is best entrusted to properly trained rural workers, living in concerned communities, rather than to non-local irrigation department staff.

28. Project implementation schedules should be critically reviewed at appraisal. The entire procurement process should be detailed, including all in-house and external approvals (Bank, the Budget Bureau, etc.) required prior to contracts signing. Experience indicates that at present at least eight months are required for major ICB procurement.
29. Start-up delays caused by protracted rights-of-way acquisition procedures could be minimized if the Bank required implementing agencies to secure rights-of-way for at least those construction segments to be implemented during the first project year by the time of loan negotiations, and to have at least initiated rights-of-way acquisition for the second project year by appraisal. Project schedules should allow for appropriate delays in start-up (a year or more, depending on the nature of facilities to be built) in cases where, for various reasons, such requirements could not be met.

30. The systems for computerized water scheduling and monitoring (WASAM) and automated maintenance planning process (AMPP) introduced at MKRB have had a very large beneficial impact. The work done and experience gained in the economic monitoring and evaluation of MKRB was also of great value, and RID should consider extending these systems.
THAILAND
MAE KLONG IRRIGATION PROJECT-MALAIMAN PHASE I
(TWELFTH IRRIGATION PROJECT)
(LOAN 2022-TH)
PROJECT COMPLETION REPORT

Overview

General

1. This Overview is based on the Project Completion Report (PCR) of the Mae Klong Irrigation Project-Malaiman Phase I (Irrigation Project XII) prepared by International Land Development Consultants (ILACO) in association with Empire M&T Co. Ltd., under a contract from the Government of Thailand. It also draws on the Loan Agreement, the Bank's Appraisal Report, supervision mission reports, correspondence with the Borrower, and internal memoranda in Bank files.

Project Objectives

2. Irrigation Project XII was designed to assist the Royal Irrigation Department (RID) in its continuing program to improve and expand Thailand's irrigation facilities aiming to raise farm incomes through increased cropping intensities and yields for about 27,000 ha of paddy land directly benefitting about 44,000 people. This was to be achieved by construction of main canals, lateral, sublateral canals and service roads. It also included construction, improvement and enlargement of drains, construction of on-farm development (OFD) in West Malaiman area, and improved Operation and Maintenance (O&M). The project was expected to increase agricultural and agriculture-related employment opportunities and income through generating demand for additional labor which will benefit 13,000 landless agricultural people living in the project area. The project was also expect to provide for the preparation of future irrigation projects, and further improve RID's operational capability through improvements in RID's operational complex. Finally the project was expected to lead to an increase in foreign exchange earnings through an increase in the production of exportable commodities (i.e. rice and sugar).

Appraised Components of the Project

3. Irrigation and Drainage Systems. The main features of this component were:

3.1 construction of 19 km of main canals and service roads;
3.2 construction of 164 km of lateral and sublateral canals and service roads;
3.3 improvement and enlargement of 70 km of main and secondary drains and construction of 130 km of new secondary drains; and
3.4 on-farm development including tertiary systems (tertiary canals,
drains and farm roads) for a total area of 27,000 ha with turnouts to areas of (about) 4 ha each.

4. **Institutional Improvement.** This component provides for strengthened collaboration within RID mainly through staff training and some increases in staff.

5. **Preparation of New Project.** The main features of this component were:

   5.1 selection of potential projects and preparatory studies;
   5.2 preparation of updated feasibility studies of 2 earlier selected projects in Northern Thailand (the Mae Yom and Mae Kok Projects) covering 90,000 and 20,000 ha respectively;
   5.3 preparation of detailed designs and contract documents for the dams and for the initial stages of the irrigation system of the Mae Yom and Mae Kok projects (subject to viable ERRs as determined under paragraph 5.2). Activities might also include detailed design of medium scale and small scale irrigation schemes;
   5.4 baseline surveys of selected potential projects.

**Implementation**

6. **Organization.** The implementation of the project was under the responsibility of the RID of the MOAC while agricultural supporting services were carried out by other departments and divisions of the MOAC (i.e. DAE, rice division) and an institutional lender such as BAAC. Within RID's Department, the Deputy Director General for construction and a senior RID engineer from the Greater Mae Klong Irrigation Project acted respectively as Project Director and Project Manager for this project. In addition, a Project Engineer was appointed to coordinate field operations in the project area. An association of consultants (paragraph 1) assisted the Project Management in design and construction supervision of the different project components.

7. Organizational arrangements were generally satisfactory. The Project Director, Project Manager and Project Engineer were all appointed as planned at appraisal. All positions were incorporated into a project organization structure with clear divisions of authority. The Project Manager was responsible for all aspects of project implementation and the Project Director coordinated activities of functional divisions within RID, other government agencies and consultants. This system, in contrast to earlier versions, contributed to a clearer definition of responsibilities for all parties concerned and improved the quality and timing of project implementation. It also strengthened both senior and mid-level management.

8. **Construction of Irrigation and Drainage Systems.** The following components have been implemented at a generally satisfactory quality: (the figures in between brackets indicate appraised quantities)

   8.1 construction of 18.0 km (19 km) of main canals and service roads;
   8.2 construction of 169.0 km (164 km) of lateral and sublateral canals and service roads;
8.3 improvement and enlargement of 76.0 km (70 km) of main and secondary drains and construction of 145 km (130 km) of new secondary drains;
8.4 construction of OFW (tertiary canals, drains and roads) covering an irrigable area of 22,000 ha (27,000 ha).

9. It was anticipated at appraisal that the project would be completed in five years, e.g. by June 30, 1986, and that the loan would be closed on June 30, 1987. Actually, the Loan Closing Date was extended to June 30, 1988 and disbursements continued until December 31, 1988. The longer than expected implementation period was due mainly to: (i) time required to survey part of the area which was covered by inadequate aerial photography and missing benchmarks (PCR Section 2.2.2); (ii) repeated modifications of designs of drainage and on-farm works (PCR Section 2.2.4); (iii) protracted procurement procedures (PCR Sections 2.4 and 2.6); (iv) poor organization of contractors and inefficient construction procedures (PCR Sections 2.4 and 2.6); (v) poor condition of equipment (PCR Section 2.4); (vi) cash flow problems (PCR Section 2.4); (vii) inclement weather during long stretches of the 1986 wet season (PCR Section 2.4.2); and (viii) protracted negotiations with farmers on R-O-W acquisition for O/F ditches and drains (PCR Sections 2.2.4 and 2.9).

10. Institutional Improvement.

(a) An important improvement in RID's institutional capability was the establishment of a feed-back mechanism from the field to the design office. By institutionalizing regular contacts between construction supervisors and designers and between O&M personnel and designers, field personnel were able to articulate to designers problems they had encountered either during construction or during operation. Designers, on their part, had an opportunity to analyze encountered problems and ascertain implications upon system design. For example, turnout gates, which presented operational problems in many (if not most) RID's projects, were re-designed and improved in response to O&M comments.

(b) A second important improvement in RID's operational capability was achieved through the introduction of computerized water scheduling and monitoring. By adapting software to local needs, the Consultant developed daily/weekly delivery schedules (WASAM) for mains and laterals of the irrigation system, down to tertiary turnouts. These were based on gross consumptive use requirements and present a breakthrough in RID's attempts to match water supplies with demands. (The same system could be used to schedule deliveries from teritories to individual and/or groups of farms). Computerized monitoring of programmed schedules was introduced and results (monthly monitoring graphs) were discussed by the O&M staff of each Zone.

(c) A third improvement in RID's maintenance capability was achieved by the Consultant's introduction of a computerized, automated maintenance planning process (AMPP). This program served as an incentive to RID's O&M staff to first critically review all various maintenance activities, classify them in accordance with required frequencies to sustain system performance and finally plan activities in proper sequence and frequency. (It should be noted that RID decided recently to adapt and employ programs developed for this project
nationwide.)

(d) A fourth improvement in RID's capability concerned training of irrigators. It was achieved by providing fully equipped mobile training units (e.g. audio/visual aids, training booklets, irrigation calendars, and various other training materials).

(e) The project also improved RID's coordination capability with irrigators by establishing Working Committees at Amphoe (District) level. These committees helped coordinate activities of different agencies in forming and training of Water User's Groups (WUG) in newly developed area. The Committees also provided agricultural guides -- in addition to that provided by Provincial Committees for Land Consolidation (POLC).

11. **Preparation of New Projects.** Crop Diversification Study on the West Bank of the Chao Phya. Upon the request of MOAC, Loan 2022-TH financed a major identification and prefeasibility study by the Project Consultant on crop diversification on the West Bank of the Chao Phya. The study found little potential for dry-footed field crops (such as soybean, cotton and mungbean) or exportable fruits and vegetables due to limiting soil capabilities, but some potential for fruits and vegetables for local consumption, for combined aqua-rice culture (particularly fresh-water prawns) and for growing of orchids. In view of rapid deterioration of water quality selective, uncoordinated, flood control in parts of the basin (exacerbating floods in other parts), and already experienced water shortages, the study recommended a follow-up re-assessment of water management in the Mae Klong and Chao Phya basins and the zoning of the area for various economic activities.

12. However, neither these nor additional studies were carried out under this project because of MOF's objection to use proceeds from this loan for further project preparation or follow-up studies.

**Project Costs and Disbursements**

13. The appraised cost of the project was US$115.0 million, with a foreign currency component of US$57.0 million. By loan closure (June 1988) the actual total project cost (TPC) was US$ 79.7 million and total disbursements under the loan aggregated US$34.4 million. Factors that contributed to the reduction in TPC were: (a) service area reduction (O/F development covered only 22,000 ha instead of an appraised area of 27,000 ha); and (b) a decline in the value of the Thai currency which resulted in a 25% devaluation and which reduced the TPC in US$ equivalent. Loan disbursements commenced during the second project year (IBRD FY 1982), but lagged behind the appraised disbursement schedule by 55-75%. Upon RID's and MOF's request the Bank cancelled a total of US$22.6 million from proceeds under the loan ($19.0 million on June 17, 1987; $3.0 million on August 9, 1988; $0.6 million on January 18, 1989).

**Agricultural Production**

14. The reassessed agricultural potential of the project at loan closure was as follows. Of the 22,000 ha where O/F facilities were provided, cropping
intensities are now expected to reach 172% at full development (178%)\(^1\); however, yields are expected to exceed appraisal estimates\(^2\). Yield of local transplant wet season rice recorded at appraisal as 1.7 ton/ha, was 2.5 ton/ha in 1987 and is expected to further increase at full development\(^3\) by about 30% to 3.3 ton/ha compared to an appraised target yield of 3.0 ton/ha. Yield of HYVs wet season rice\(^4\) was 3.4 ton/ha in 1987 and is expected to increase at full development to 4.1 ton/ha compared to an appraised target yield of 3.5 ton/ha. Yield of HYVs dry season rice in flooded areas increased from 2.8 ton/ha at appraisal to 3.9 ton/ha in 1987 and is expected to increase to 4.5 ton/ha at full development compared to an appraised target yield of 3.2 ton/ha. Yield of HYVs dry season rice\(^5\) in non-flooded areas was 3.8 ton/ha in 1987 and is expected to increase at full development to 4.2 ton/ha compared to an appraised target yield of 4.0 ton/ha. Yield of sugar recorded at appraisal as 35.0 ton/ha was 60 ton/ha in 1987 and is expected to increase to 80.0 ton/ha at full development. At appraisal, sugar was not expected to be planted under the project.

**Impact**

15. The major impact of the project was an increase in rice production (both wet and dry season) and sugar production through increased yield, expanded areas and increased intensities primarily by increasing cropped areas during the dry season. (Table 1, page 7) This led to an increase in farm incomes. At full development, the annual net incremental farm income is expected to be approximately 4,400 Baht per hectare. As a consequence of these developments, labor requirements and wages also increased. Labor and wages are expected to increase at full development by 30 workdays/hectare and between 5 to 10 Baht/workday respectively. The project provided significant improvements in water management and in improved inter-departmental cooperation within RID and in improved contacts with irrigators. Mainly because of MOF's objection to use this loan for studies, no new projects were prepared under this loan. Finally, the increase in the production of exportable commodities (i.e. rice and sugar) also led to an increase in foreign exchange earnings. From 1982-1986 Thailand's rice exports had increased about 14.2%.

16. The appraisal report estimated the project ERR at 23% based on Fall 1981 Commodity Price Forecast data. The Borrower's PCR re-estimated the ERR at 11%, based on Fall 1987 Commodity Price Forecast data (in 1985 constant US

\(^1\) the figure indicates the amount expected at appraisal

\(^2\) Yield figures for 1987 are based on averages of actual data obtained from field observations and various other sources (RID Mae Klong Project, Agricultural Extension Service); Yield figures for 1988 and beyond are projections.

\(^3\) The appraised target yields were to be reached at full development - in the sixth year after completion of project works or in 1994

\(^4\) introduced with the project

\(^5\) also introduced with the project
Dollars) and on adjusted costs to September 1987. Major factors contributing to the reduction of ERR from the appraisal estimate are: (a) benefits started accruing only in the sixth year of the project instead of the second year as assumed at appraisal; (b) considerably lower economic prices of paddy; (c) an overestimation of incremental production. (PCR Section 6)

17. The Bank reassessed the ERR as 7.2% based on same production projections as given in the PCR but substituting the latest (September 1988) Commodity Price Forecasts for the earlier (1987) forecast used in the PCR. (table 2, page 8) This substitution, of a yet lower forecast, dropped the ERR from 11% to 7.2%.

Bank Performance

18. The Bank dealt adequately with some issues at appraisal but not with all. Thus: (i) the time estimated for implementation was too short; (ii) the economic assumptions were overly optimistic and thus resulted in overstating the project ERR; (iii) there was a lack of economists during supervision and hence little attention was given during supervision to an actual reduction in economic benefits; (iv) the Bank did not insist that RID obtain farmers' cooperation before the actual construction of O/F system, and as a result delays occurred during implementation.

Lessons Learned

19. R-O-W problem which stemmed from farmers' unwillingness to yield land access for farm ditches and drains was primarily due to a lack of early, effective contacts between RID and future irrigation users. This problem resulted in a delay and a reduction of OFD and delayed derivation of benefits. Attention should therefore be given to involving the benefitting farm population in project preparation allowing them to articulate their legitimate expectations from irrigation. Based on these discussions RID should be able to appropriately plan the project and reach appraised project objectives.

20. With hindsight, it is evident that the appraised implementation schedule of 5 years was far too optimistic. The bank should have anticipated the likelihood of shortcomings common to other projects implemented by RID at appraisal (i.e. delays in awarding contracts, protracted negotiations for R-O-W, etc.). Implementation of similar schemes should be planned for longer periods of time (i.e. 7 to 8 years).

21. Another important lesson learned concerns the water management system and maintenance planning. RID should consider expanding the knowledge gained from the improved water management system (WASAM) and from automated maintenance planning (AMPP) by implementing these systems which already had a positive impact on this project to other similar developments throughout Thailand.
### TABLE 1: KEY PRODUCTION ASPECTS OF THE PROJECT

<table>
<thead>
<tr>
<th></th>
<th>1981 Situation</th>
<th>Appraisal Estimates¹</th>
<th>Actual/Anticipated at Full Agric. Development</th>
<th>Percent of Appraisal</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cropped Area (ha)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paddy</td>
<td>26,000.0</td>
<td>45,500.0</td>
<td>34,600.0</td>
<td>76.0</td>
</tr>
<tr>
<td>Sugar</td>
<td>900.0</td>
<td>-</td>
<td>3,300.0</td>
<td>-</td>
</tr>
<tr>
<td><strong>Cropping intensities (%)</strong></td>
<td>100.0</td>
<td>178.0</td>
<td>172.0</td>
<td>96.6</td>
</tr>
<tr>
<td><strong>Yields (ton/ha)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Local transplant</td>
<td>1.7</td>
<td>3.0</td>
<td>3.3</td>
<td>110.0</td>
</tr>
<tr>
<td>wet season rice</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HYVs wet season rice²</td>
<td>-</td>
<td>3.5</td>
<td>4.1</td>
<td>117.1</td>
</tr>
<tr>
<td>HYVs dry season rice³</td>
<td>2.8</td>
<td>3.2</td>
<td>4.5</td>
<td>140.6</td>
</tr>
<tr>
<td>HYVs dry season rice</td>
<td>-</td>
<td>4.0</td>
<td>4.2</td>
<td>105.0</td>
</tr>
<tr>
<td>Sugar</td>
<td>35.0</td>
<td>-</td>
<td>80.0</td>
<td>-</td>
</tr>
</tbody>
</table>

¹ The appraised target yields were to be reached at full development - in the sixth year after completion of project works or in 1994.

² The numbers used here are the average of transplanted and broadcasted HYV wet season rice yields.

³ in flooded area
TABLE 2: PROJECTED PRICES FOR RICE AND SUGAR

(in 1985 constant US Dollars)

<table>
<thead>
<tr>
<th>Years</th>
<th>Rice Price Forecast</th>
<th>Suger Price Forecast</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sept. 1987</td>
<td>Sept. 1988</td>
</tr>
<tr>
<td>1987</td>
<td>169</td>
<td>177</td>
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<tr>
<td>1988</td>
<td>175</td>
<td>215</td>
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<tr>
<td>1989</td>
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<tr>
<td>1990</td>
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<td>165</td>
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<tr>
<td>1995</td>
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<tr>
<td>2000</td>
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<td></td>
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<tr>
<td></td>
<td>115</td>
<td>240</td>
</tr>
<tr>
<td></td>
<td>268</td>
<td>300</td>
</tr>
<tr>
<td></td>
<td>224</td>
<td>254</td>
</tr>
</tbody>
</table>

(F.O.B Bangkok, 5% broken, export-quality Thai white rice)
This Summary is extracted from the lengthy report prepared by the consultants Ilaco in Association with Empire M. & T. Co. Ltd. for the Royal Irrigation Department. Copies are on file at the Operation Evaluations Department and are available on request.
SUMMARY

Introduction

The Mae Klong Irrigation Project - Malaiman Phase I was implemented during the period 1901-1988 and will actually be fully implemented in 1989. It was the second large scale agricultural development project in the Mae Klong Basin following similar agricultural developments on the Right Bank and in the Chao Phya Basin.

Approximately 53.5% of the Project was financed by the Royal Thai Government, while for the other 46.5% a loan from the World Bank (IBRD Loan 2022-TH) was obtained.

The objectives of the Project i.e. increase of the wet-season rice yields, the extension of the dry-season cropped area, the creation of possibilities for agricultural diversification and the improvement of rural employment opportunities, have been fully achieved.

Unlike the Chao Phya Basin, where irrigation water is not sufficient for the dry season irrigation of the entire area, the Greater Mae Klong Irrigation Project in the Mae Klong Basin, of which the Mae Klong Irrigation Project - Malaiman Phase I is a part, to date receives an adequate water supply in the dry season. However, it should be understood that in view of the expansion of the area under irrigation and the fact that water from the two reservoir dams (the Srinagarind dam and Kao Laem dam) is also being diverted to the Chao Phya West Bank and Bangkok Metropolitan, much attention should be paid to improve irrigation efficiencies.

The construction of tertiary irrigation, drainage and road facilities has improved crop-growing conditions to such an extent that broadcasting and transplanting of local rice varieties has been almost entirely replaced by transplanting and nowadays even broadcasting of pre-germinated seed of modern rice varieties. Dry-season cropping in the project area has increased tremendously. As a consequence of these developments, labour requirements increased significantly and labour wages followed suit. Because of the necessity to complete certain farm activities in a short period of time in the double cropping system (harvesting, land preparation and transplanting), the fact that the labour requirements during these periods could not be fully met and the resulting high labour wages, farmers turned to mechanized land preparation and broadcasting of pre-germinated seed.
Project implementation

In the Mae Klong Irrigation Project - Malaiman Phase I the following main components have been implemented (the figures between brackets indicate the amounts at appraisal):

(i) construction of 18.0 km (19 km) of existing main canals and service roads;
(ii) construction of 169.0 km (164 km) of lateral and sub lateral canals and service roads;
(iii) improvement and enlargement of 76.0 km (70 km) of main and secondary drains and construction of 145 km (130 km) of new secondary drains;
(iv) construction of on-farm works (tertiary canals, drains and roads) covering an irrigable area of 22,000 ha (27,000 ha).

A comparison between the planned implementation schedule at appraisal and the actual implementation schedule is shown in Figure 1.1.

The Project was implemented under the responsibility of the Royal Irrigation Department (RID) of the Ministry of Agriculture and Co-operatives (MOAC). A Project Manager was appointed, who reported to RID's Deputy Director General for Construction. An association of consultants assisted the Project Management in the implementation of the different project components. In actual fact the same Project Manager and Consultants were involved in this Project as in the Mae Klong Right Bank Irrigation Project, which was simultaneously being developed. This made it possible to set up an efficient management team to coordinate activities in both projects.

Topographical surveys and cadastral surveys for the design of the tertiary system were based on 1:4,000 scale aerial photographs and executed by respectively RID's Survey Division and the Land Department. Surveys of the new distribution system were carried out by local survey contractors. This was supervised by the Consultants, who were responsible for all design work in this Project.

The design work of the main and secondary irrigation and drainage system was done by Consultants, who used the same Design Office which was established for the Mae Klong Right Bank Irrigation Project for this purpose.

Main features of the design of the supply system were a raise of capacity to 1.6 and 1.5 l/s/ha for main and lateral canals respectively, incorporation of additional structures to raise and control the water levels and allow for full command of the command areas even under low supply conditions and for better operation.

The lay-out and capacity of the drainage system was reviewed, taking into account the need for cross drainage through the project area of drainage water from the western catchment areas. Additional cross drainage structures were
### Implementation schedule of Mae Klong Irrigation Project Malaiman Phase I
(IBRD loan 2022-TH)

<table>
<thead>
<tr>
<th>Year</th>
<th>Description</th>
<th>Appraisal</th>
<th>Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>1981</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1982</td>
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<td>1983</td>
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<td>1988</td>
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<td></td>
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</tr>
<tr>
<td>1989</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note**
- Implementation schedule at appraisal
- Actual implementation schedule

**Figure 1.1**
designed in the 1L main canal for this purpose. Further, a flood protection dike in East Malaiman was constructed so as to protect the on-farm works in that area.

The designed tertiary system is of the so called 'extensive land consolidation' type (Type B) i.e. the ditches, roads and drains follow the existing cadastral boundaries. Hence, no reallocation of plots and no land levelling was allowed for. However, as 100% of the farmers had to be connected to the water supply, drainage and road system, it can still be considered an intensive development. Farmers were involved in an early stage of the design. In total about 22,400 ha were designed by the Consultants Design Office. The on-farm designs for sugarcane areas were somewhat adapted to take care to the specific needs in those areas.

The equipment and materials procured under the Mae Klong Irrigation Project - Malaiman Phase I included Construction and O&M equipment for respectively US$ 952,470.- and US$ 902,380.-.

At appraisal, project implementation was estimated to take six years. However, due to time consuming tendering procedures, obstructing farmers, national budget limitations and considerable delays in some civil works and OFD contracts, the civil and on-farm components could not be completed in time. Consequently, the Project and the Loan had to be extended with one year i.e. from June 30, 1987 to June 30, 1988.

The construction of civil works was mostly done by contractors and a minor part by Force Account (some drains). The quality was generally good.

The construction of on-farm facilities was done by Contract, in total 22,000 ha and will be completed in 1989. The progress and quality was at first, disappointing in West Malaiman due to inexperience of project staff with this type of work. Moreover, the short construction time available required accurate planning of work. Consultants extensively trained inspection staff to improve the quality while the Project Management and contractors were assisted in scheduling of the work. In later years the quality improved considerable.

The Consultants time input under the Project was spent on design, assistance to the Project Management in the implementation, assistance to the Regional O&M Office in Operation and Maintenance, and assistance to the Project Planning Division (Economic Branch) in Monitoring and Evaluation of the Project.

Operation and maintenance

A very important part of the project activities included the establishment and implementation of improved O&M practices at farm level and at project level from the very beginning of the Project.
The integrated development approach which was followed, in which a very close co-operation and interaction between design, construction, O&M and economic monitoring and evaluation was strived after, proved to be of great value for the development of the area. An important aspect of this component was the training of RID field staff and the farmers in the proper use of the rehabilitated and newly constructed irrigation and drainage systems. To this end, also mobile training units were developed and equipped with adequate hardware and software, e.g. visual/audio visual aids as training booklets, irrigation calendars, films, slides sound series, etc. Another important step taken, to come to higher irrigation efficiencies, was the development of a Water Allocation Scheduling and Monitoring (WASAM) programme. Maintenance activities were analysed and an Automated Maintenance Planning Process (AMPP) programme, to structure the maintenance process, was developed.

Project expenditures and disbursements

The total project cost will reach at completion in 1989 an estimated amount of Baht 1,887.3 million or US$ 75.5 million equivalent (1988 conversion rate). This total is some 18% under the estimate made at the time of appraisal (1979) and is mainly due to the fact that the actual total area of on-farm development implemented was 22,000 ha instead of 27,000 ha anticipated at appraisal, even though the unit rate for OFD construction was higher than anticipated. It was also partly caused by the change in exchange rate from ฿ 20 per US$ in 1981 to ฿ 25 - ฿ 26 per US$ during the period 1985/1988.

The original Agreement between the Government of Thailand and the International Bank of Reconstruction and Development was based on a Loan of US$ 57.0 million. This figure was reduced in 1987 to US$ 38.0 million. The estimated final disbursements will, however, only reach a total of some US$ 35.1 million. The main reason for the considerably lower loan disbursements is that some construction work has been carried out under force account instead of on contract. For force account work no disbursement was included in the loan. Moreover as mentioned in the previous paragraph less on-farm implementation was carried out and considerable difference in exchange rates have also caused the disbursements to be less than anticipated at appraisal.

Agricultural development

Monitoring of agricultural development, including the establishment of a set of detailed baseline data in the Mae Klong Right Bank Irrigation project area was initially done in close co-operation with the Economic Branch of RID's Project Planning Division. As a result of Consultant's recommendations to establish an in-house Monitoring and Evaluation Unit, all project benefit monitoring and evaluation activities since 1985 have been carried out in co-ordination with RID's Project Monitoring and Evaluation Branch. All M&E activities have been
carried out in close co-operation with project staff and the Consultants. Due to delays in the implementation the first actual monitoring activities, covering initially only small implemented areas, started in 1984.

Cropping intensities in the implemented areas went up in two to three years from 105% to at least 170-180% calculated for the total OFD area (rice and sugarcane). For rice areas in particular, the dry season cropping intensity went up from some 5% to almost 85%. Wet season rice intensities may drop in the near future to 95% because of still existing flooding problems in small parts of East Malaiman.

No information exists on other crops than rice and sugarcane. In case farmers will start to grow more vegetables in the near future, the cropping intensity will increase even further.

To solve the problem with respect to the increase in the demand for farm labour due to increased cropping intensity and strict irrigation schedules, farmers are changing their cultivation practices. Land preparation activities are at present increasingly mechanized with small two-wheel tractors. Besides mechanized land preparation, the introduction of mechanized threshing has also been generally accepted. The same holds true for small motorized spraying equipment. Moreover farmers are changing from the very labour intensive transplanting to broadcasting of rice. Because of the improved water management conditions (proper supply of irrigation water and an adequate drainage system) several farmers switched to broadcasting of pre-germinated seed. It is, however, expected that the majority of the farmers will continue to transplant part of the rice crop because of the severe weed problems in broadcasted rice fields, and because East Malaiman still has a flooding problem in some parts.

Initially the paddy yields increased considerably in the newly implemented OFD areas. However, the rather low paddy prices have not been an incentive to invest in extra labour for proper crop cultivation practices and/or in the application of extra agro-chemicals. Consequently, yields showed a decreasing trend in 1985 and 1986. Recent price increases have shown immediate improvements in the paddy as well as in the sugarcane yields. The projected yield targets, as given in the Appraisal Report, have been reached by the farmers in the project area in a much shorter period than originally foreseen.

Assuming that paddy and cane prices will remain at fair levels, the stage of full development can be reached by 1990. For paddy this means yields for transplanted HYV of 4.3 ton/ha in the wet season and 4.5 ton/ha in the dry season. For broadcasted HYV the expected yields are respectively 3.8 and 4.2 ton/ha.

Monitoring results showed that the yields which can be expected without project implementation would be higher than forecasted in the Appraisal Report. For details on actual recorded and projected yields for paddy and sugarcane reference is made to Table 4.3.
Production costs have been influenced by the changes in cultivation practices but in particular also by the relatively low farmgate prices of paddy and cane. To keep the Net Value of Production (NVP) as high as possible farmers reduced labour costs and the use of agro-chemicals.

Trends in farmgate prices between 1980/81 and 1985/86 have had a negative effect on net farm incomes. Although the projected paddy and cane farmgate prices for 1990-2010 (based on WB commodity price forecasts for the year 2000) are better than the prices in recent years, they cannot be compared with the price projections used in the Appraisal Report. A projected economic paddy price at present and up to the year 2010 of $3,570/ton, compared with a farmgate price of $6,900/ton forecasted in 1979 will have an important effect on the viability of the Project as a whole.

**Project evaluation**

Several important facts have influenced the feasibility of this Project in a rather negative way. The most important one is the delay in the implementation of OFD works. The fact that the first and relatively small areas had been completed only in 1983 and not in 1982 as foreseen during the appraisal and that the total project area can benefit from the new irrigation and drainage infrastructure only in 1990 instead of 1987, has reduced the rate of return considerably.

The Project also appeared to be quite sensitive to the rather low prices of paddy and sugarcane. The economic analyses, however, also indicated that the project has been less sensitive to increases of up to 20% higher investments or changes of plus or minus 10% in yields. Summarizing it can be said that the feasibility of the Project (ERR = 11%), on the basis of conditions of today, is considerably lower than the calculated 23% from the Appraisal Report. Without delays in implementation the ERR would have been 15%, calculated on the basis of prices used in 1979 the result would be 18%. Also important is that the differences between with and without project implementation have proved to be less than expected. However, despite all these facts, the conclusion must be that, under present 1988 conditions, the outcome of the economic analysis is good and probably better than many other and comparable projects, even when the production of high value crops such as vegetables in the project area in the near future is not taken into account.
CONCLUSIONS AND RECOMMENDATIONS

The Mae Klong Irrigation Project - Malaiman Phase I, turned out to be a successful large scale irrigation project. Not only in terms of economics, but also in terms of farmer's co-operation and participation. In an area of about 22,000 ha the physical infra-structure will be such that the conditions for the cultivation of rice or upland crops are optimal and maximum yields can be achieved. The rise in dry season cropping intensities after implementation and the increase in yields are good indicators that the farmers utilize the offered facilities to their full extent.

The ideas developed and experiences gained in the field of engineering, project implementation, water management and monitoring and project evaluation will reflect positively on similar development throughout the Kingdom of Thailand. Local staff have been involved in depth in the preparation of design criteria and designs for civil and OFD works. Local contractors and RID staff have gained considerable experience with the implementation of large scale on-farm development works for which there is still a wide scope in the Kingdom. The development of the Water Allocation Scheduling and Monitoring Programme (WASAM) now already has a positive impact on several projects. RID is considering to implement WASAM on all irrigation projects nation wide. The work done and experiences gained in the economic monitoring and evaluation of the Meklong Irrigation Projects can be of great value for the evaluation of other existing projects.

Within the Mae Klong Irrigation Project - Malaiman Phase I Consultants have recommended that due attention should be paid by the Project Management to the proper completion of the OFD facilities and to the drainage system and the adjacent protection dikes in the flood prone areas of East Malaiman. Due attention should be paid to the Song Phi Nong River, since the capacity of this river is not sufficient and when it cannot discharge the drainage water from the Malaiman areas fast enough severe flooding in East Malaiman may occur, also causing major damage to the distribution system.

The advised discharges by the WASAM programme should be strictly implemented. Actual discharges should be monitored and evaluated. A nucleus of trained staff should be retained for proper operation and for training of staff for other projects, in the background and use of WASAM. The coordination with EGAT should be improved to have more control over reservoir releases to the Vajiralongkorn dam.

The increased efficiency in water use in the Mae Klong Basin will allow for more efficient use of the available water resources, which will enable further agricultural developments, not only in the Mae Klong Basin, but also in the Chao Phya Basin; at present already a considerable amount of water is conveyed to the lower Chao Phya West Bank area for agricultural and domestic use.
Considering the rising trend in commodity prices and the scope for additional developments in the Mae Klong Basin, the Consultants have recommended to continue irrigation development in the Mae Klong Basin. Both in the Stage I and Stage II Left Bank areas there is still an enormous potential for more efficient water use and increases in cropping intensities and yields in case tertiary development is implemented. Especially in the Nalaiman sugarcane areas, farmers are very eager for further development and are willing to pay for OFD facilities.

It can be concluded that an integrated approach to irrigation development with attention not only for design and construction but simultaneously for operation, maintenance and water management, leads to satisfying results. The formulation of an irrigation operation plan beforehand and feedback from the field to designers and construction staff are important elements of this approach.

The monitoring of the water distribution and the results of the agro-economic surveys also contribute to the regular, direct feedback of field information to the top level O&M staff.

Results might have been even better, if a consultancy component on agronomic aspects, such as crop diversification, extension, marketing, and credit had also been included in the Project. The latter applies especially to upland crops.

Finally, the results obtained so far have also to be contributed to the diligence of RID's O&M organization, which, understaffed still made the Mae Klong Irrigation Project - Nalaiman Phase I an outstanding example for modern Operation and Maintenance of an irrigation project in Thailand. The good cooperation between project construction staff and O&M staff was an essential contribution to this success therefore, it is strongly recommended to follow a similar approach for future developments.

Considering the increasing complexity of the management and further development of the central plain river basins with regards to flood control, irrigation and drainage, water availability and use, reservoir operation etc., and the interrelationship between the Mae Klong and Chao Phya River Basins, Consultants recommend an integrated Chao Phya and Meklong River Basin Development Study. This study should include such fields as water resources development and crop diversification, river basin planning, hydropower, agricultural development, irrigation, drainage, flood plain management, river hydraulics, hydrology, salinity intrusion, water quality, ecology, sociology, navigation and organization.

An important aspect in managing the water supply to the different irrigation projects in the Mae Klong as well as the Chao Phya Basins is the future integration of the existing WASAN and WMS programmes.
Dear Mr. Donaldson,

We have received the draft Project Performance Audit Report transmitted by your letter dated August 20, 1990, for our comments.

The purpose of this report is to serve as a repository for lessons learned by the Bank in retrospect which may be used as reference for future lendings. The discussions as embodied in the said draft report do touch with the World Bank former project appraisal missions as well as touching the policies adopted by the Thai government at such period of time, the Royal Irrigation Department does not feel that any more comments seem necessary.

It is appropriate however to reiterate to you that the economical and social aspects of Irrigation Projects XI and XII, as well as the way of thinking in respect to the design engineering of the system, have been carried out at the recommendation of the Consultant with the knowledge of and approved by the Bank and its subsequent follow-up missions, i.e., the design was adopted on a compromising basis between high-tech and conventional gravity flow system.

We have taken note on some of the issues pertaining to O&M of the system at both projects. Such happenings are normal as the result of the existing social environments of the Thai farmers. We have always been trying to eliminate, improve and to remedy but this takes some time.

The attached document give some facts and figures not clearly mentioned, otherwise gives explanations to some of the issues pointed out in the draft report.

In the meantime, we are,

Yours sincerely,

(Roongrueng Chulnata)
Deputy Director General
Director General

Graham Donaldson
Chief, Agriculture, Infrastructure and
Human Resources Division
Operations Evaluation Department
The World Bank
1818 H Street, N.W., Washington D.C.
U.S.A.
Irrigation Projects XI and XII

(1) Decrease Project Area (Audit Summary item 22)

In Mae Klong Right Bank, the project area was decreased from 60,000 ha to 44,500 ha actually implemented up to the end of 1989.

The difference equals to 21,500 ha may be explained as follows:

9,900 ha Area out of command.
10,000 ha Area not designed due to failure to obtain agreement of the farmers or owners.
1,600 ha Area designed for construction, but cancelled afterwards due to farmers obstruction.

N.B. Please make corrections due to clerical error found in Audit Summary item 18 line number 19 the words "Right Bank" and "Left Bank" were misplaced.

(2) Loan Cancellations (Audit Summary item 27)

The reasons leading to cancellation of loan amount, as high as 32.0% and 39.5% for Irrigation XI and XII, may be explained as follows:

2.1 The actual implemented areas were reduced approximately:

Mae Klong Right Bank reduced by 33%.
Mae Klong Left Bank reduced by 15%.

For Pattani only 29% of the project area were constructed at the loan closing date.

2.2 At project appraisal stage, the exchange rate adopted was US$ equivalent to 20 Baht. But during implementation, the said exchange rate was changed and varied between 23 Baht to 26 Baht to one US$.

2.3 Problems about land ownership in Mae Klong Right Bank resulting in very high complication to permit construction by contracts as planned. Thus it was decided to construct the On-Farm facilities by RID force account for our convenience.

Force account work expenditures could be met by the loan proceeds on a fixed rate per hectare. These rates were far below the actual expenditures.

2.4 Much of the import items which could be disbursed from the loan proceeds at 100% of CIF Bangkok prices were cancelled due to RTG procurement regulations.
(3) **Control structures not calibrated** (Audit Summary item 28)

On this issue, the Consultant recommended in PGRs of Mae Klong Projects that a number of control structures, marked with "C", should be checked for accuracy prior to the operating season following the project completion.

The checkings were not accomplished at the time of the visit of the audit staff in February 1990 due to a number of reasons. However, we shall see to it that such checkings are accomplished as soon as possible.

(4) **Off-take structures damaged by farmers** (Audit Summary item 28)

This occurred to the Romijn weir structures in the on-farm work area of the WASAM system. The system was placed under the care and maintenance by the Water Users Group, while the gate settings are assisted by RID Gate-Tenders and Zonemen.

In spite of the fact that members of these Water Users Groups had been trained to be familiar with WASAM system and the way the system works, at the time of intermittent drought when the water released from upstream have not reached the area as yet, the farmers tend to cause damage to the structures either by the fact that they do not understand or by habitual acts.

This problem is being corrected by forcing the Water Users Group to collect monies from the members who caused the damages in order to meet the repair cost. This problem will gradually be eliminated in the course of time.

We believe that WASAM system will work satisfactorily at Mae Klong Project, where the amount of water is abundant. The system is not introduced at Pattani at the present time, and in other regions the system may be applied if and where it is considered will render better result.

(5) **Siphoning** (Audit Summary item 28)

This occurred in Mae Klong Left Bank at Song Phi Nong Sub-Project, where the sugar field is located adjacent to 2R canal. The sugar field is outside the area covered by the Bank financed project area.

After Irrigation XII loan closing date, the RTG provided budget allocation to provide water to cover the whole area of the Right Bank. While the system is under design it is neccessary to permit the sugar field to temporarily draw the required water from the nearby canals until the system is constructed.
LAO PEOPLE'S DEMOCRATIC REPUBLIC

THAILAND
IRRIGATION DESIGN AND MANAGEMENT
NORTHEASTERN REGION

UNDER CONSTRUCTION

NEW PROJECTS

IMPROVEMENT PROJECTS
EXISTING

DAMS AND RESERVOIRS
IRRIGATED AREAS
HILLY AND MOUNTAINOUS AREAS
NOT SUITABLE FOR IRRIGATION

ROADS
RAILWAYS
RIVERS AND DIVERSION DAM
RIVER BASIN BOUNDARIES
REGION BOUNDARIES
INTERNATIONAL BOUNDARIES
THAILAND
IRRIGATION DESIGN AND MANAGEMENT
SOUTHERN REGION

UNDER CONSTRUCTION
NEW PROJECT

IMPROVEMENT PROJECT

DAM AND RESERVOIR

EXISTING
IRRIGATED AREAS

ROADS

RAILWAYS

RIVERS AND DIVERSION DAM

HILLY AND MOUNTAINOUS AREAS
NOT SUITABLE FOR IRRIGATION

REGION BOUNDARIES

INTERNATIONAL BOUNDARIES

KILOMETERS

MILES

0 20 40 60 80 100

0 20 40 60

THAILAND

BURMA

MYANMAR, LAO PEOPLES DEM. REP.

MALAYSIA

AMBON

AREA OF MAP

102°