PERFORMANCE AUDIT REPORT

MYANMAR

TANK IRRIGATION PROJECT
(CREDIT 1315-BA)

June 27, 1996
Currency Equivalents

Name of Currency: Kyat (K)

Rate of Exchange (End of Year):

- Appraisal (1981) USD1.00 = K7.2
- Average (1982-89) USD1.00 = K7.5
- Completion (1990) USD1.00 = K6.1

Abbreviations and Acronyms

- Bank: World Bank
- ERR: Economic Rate of Return
- FRR: Financial Rate of Return
- FAO/CP: Cooperative Program of the Food and Agriculture Organization
- ID: Irrigation Department
- MAS: Myanmar Agricultural Service
- mgpd: million gallons per day
- MTDC: Mudon Township Development Committee
- O&M: Operations and Maintenance
- OED: Operations Evaluation Department
- PAR: Performance Audit Report
- PCR: Project Completion Report
- SAR: Staff Appraisal Report
- SDR: Special Drawing Rights
- TA: Technical Assistance

Fiscal Year

April 1 to March 31

Weights and Measures

Metric System (except 1 acre = .405 hectare)

Borrower

Government of Myanmar
MEMORANDUM TO THE EXECUTIVE DIRECTORS AND THE PRESIDENT

SUBJECT: Performance Audit Report on Myanmar Tank Irrigation Project (Credit 1315-BA)

Attached is the Performance Audit Report on Myanmar, Tank Irrigation project, prepared by the Operations Evaluation Department. The project was supported by Credit 1315-BA for US$19 million equivalent approved in FY83. The credit was closed in FY90 with a cancellation of US$3 million, after two extensions of the closing date.

The objectives were to increase crop production and farm incomes through construction of small storage dams (tanks) and irrigation facilities at two sites and, using this experience as a pilot, to strengthen the capacity of the Irrigation Department (ID) to plan and execute similar projects. Projected cropping wet season paddy and full irrigation for diversified dry season field crops in half the area, and for the Azin site in the wet southern coast (dry season paddy and year-round orchards). The tank at Azin would also supply water to the town of Mudon.

Works were completed at Kinmundaung close to schedule, despite shortages of building materials and diesel supplies that disrupted the national economy starting only a year after implementation commenced. The ID concentrated equipment at Kinmundaung, deferring action at Azin until Kinmundaung was completed and the supply of diesel improved in 1988. The water supply system for Mudon was also delayed by over three years. The technical assistance and training components for the ID were very successful.

Irrigation supplies at Kinmundaung have proven to be only half the level anticipated, due mostly to overestimation of runoff into the reservoir, but also to a prolonged period of less than normal rainfall. Supplementary supplies of irrigation water in the wet season can be provided to only fifty percent of the area within the project perimeter, and the part planted in the dry season is only twenty percent of the appraisal estimate. Irrigation supplies at Azin have matched expectations, and the Myanma Agricultural Service is presently testing the introduction of a third crop, unanticipated at appraisal. The Mudon water supply system is operational, but township demand is far less than anticipated for reasons that have yet to be clarified but seem to be partly attributable to rising groundwater and improved supplies from wells. The fall in the international price of rice since the project was approved lowers the re-estimated rate of return for the Azin sub-project from 11 percent to 7 percent. The rice price decline together with the reduction in cropping areas result in a negative rate of return for the Kinmundaung sub-project.
Nevertheless, the outcome of the pilot Tank project is rated as satisfactory, with substantial institutional development. The ID's experience in developing the tank technology under the project led subsequently to rapid growth in construction works at additional sites, financed by the government. The irrigated paddy systems at Azin, and within the supplied zone at Kinmundaung, are functioning well and supported by adequate O&M services by the ID and the farmers. Sustainability of the farming systems and of ID's enhanced construction, operation and maintenance capacities is likely.

There are no lessons of major significance beyond Myanmar to be drawn from this project experience. The Bank was correct in continuing to support the ID and the project despite government's refusal to import the needed materials and diesel and the temptation to suspend or even cancel the balance of IDA funds. Such decisions are highly project and country specific. The risks of projecting rainfall and inflows from watersheds where no accurate meteorological data exists is universally recognized. The failure to diversify out of paddy on lands suitable for alternative crops is common to all paddy irrigation projects recently audited by OED.

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Kinmundaung Subproject (IBRD 27565)
Azin Subproject (IBRD 27566)

This report was prepared by Edward B. Rice (Task Manager), with support from U Hla Myint (Consultant), who audited the project in November 1994 and June 1995. Afi Zormelo, Diana Qualls and Megan Kimball provided the administrative support. The report was issued by the Agriculture and Human Development Division (Roger Slade, Chief) of the Operations Evaluation Department (Francisco Aguirre-Sacasa, Director).

This document has a restricted distribution and may be used by recipients only in the performance of their official duties. Its contents may not otherwise be disclosed without World Bank authorization.
Preface

This is a Performance Audit Report (PAR) on the Tank Irrigation Project, Myanmar, involving a Bank Credit in the amount of SRD 17.9 million. The credit was approved on December 21, 1982. It was closed on June 30, 1990 after one extension of the Closing Date. The undisbursed balance of SRD 2.8 million was canceled.

The PAR is based on the Project Completion Report (PCR) prepared by the Agriculture Operations Division of the then Asia Regional Office and submitted to the Board on October 11, 1991, Government's subsequent comments on the PCR, the Staff Appraisal Report (SAR), the President's Report, the Credit documents, a study of project files, and discussion with Bank staff. OED missions visited Myanmar in November 1994 and June 1995 in connection with the audit and impact studies of this project, and discussed the effectiveness of the Bank's assistance and project execution with the Irrigation Department (ID) and other relevant agencies. ID's kind cooperation and valuable assistance in the preparation of this report is gratefully acknowledged.

The PCR provides a good account of the operation of the project and the performance of the Bank and project executing authorities. The discussion of cropping patterns and the economic analysis have been updated, based on subsequent work by a consultant team under the auspices of OED's impact review.

Following standard OED procedures, copies of the draft were sent to the Government for comment. None were received.
Basic Data Sheet

Tank Irrigation Project (Credit 1315-BA)

Key Project Data (amounts in US$ million)

<table>
<thead>
<tr>
<th></th>
<th>Appraisal Expectation</th>
<th>Actual or Current Estimate</th>
<th>Actual as % of Appraisal Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Project Costs (US$ m)</td>
<td>27.1</td>
<td>30.8</td>
<td>114</td>
</tr>
<tr>
<td>Loan Amount (US$ m)</td>
<td>19.0</td>
<td>17.7</td>
<td>93</td>
</tr>
<tr>
<td>Cancellation</td>
<td></td>
<td>Close to 0</td>
<td></td>
</tr>
<tr>
<td>Economic Rate of Return (%)</td>
<td>13</td>
<td>Substantial</td>
<td></td>
</tr>
<tr>
<td>Institutional Performance</td>
<td>Several</td>
<td>None</td>
<td></td>
</tr>
</tbody>
</table>

Cumulative Estimated and Actual Disbursements

<table>
<thead>
<tr>
<th></th>
<th>82/83</th>
<th>83/84</th>
<th>84/85</th>
<th>85/86</th>
<th>86/87</th>
<th>87/88</th>
<th>88/89</th>
<th>89/90</th>
<th>90/91</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appraisal Estimate</td>
<td>0.7</td>
<td>5.8</td>
<td>12.3</td>
<td>15.3</td>
<td>17.3</td>
<td>17.9</td>
<td></td>
<td></td>
<td>17.9</td>
<td></td>
</tr>
<tr>
<td>Actual (SDR m)</td>
<td>3.8</td>
<td>4.6</td>
<td>7.1</td>
<td>10.6</td>
<td>11.4</td>
<td>14.1</td>
<td>15.0</td>
<td>15.1</td>
<td>15.1</td>
<td></td>
</tr>
<tr>
<td>Actual as % of Appraisal</td>
<td>37</td>
<td>46</td>
<td>61</td>
<td>64</td>
<td>79</td>
<td>84</td>
<td>84</td>
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Date of Final Disbursement: October 30, 1990

Project Dates

<table>
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<tr>
<th></th>
<th>Appraisal</th>
<th>Actual</th>
</tr>
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<tbody>
<tr>
<td>Identification</td>
<td>-</td>
<td>03/80</td>
</tr>
<tr>
<td>Preparation</td>
<td>-</td>
<td>01/81</td>
</tr>
<tr>
<td>Appraisal</td>
<td>10/81</td>
<td>11/81</td>
</tr>
<tr>
<td>Negotiations</td>
<td>05/17/82</td>
<td>11/01/82</td>
</tr>
<tr>
<td>Board Date</td>
<td>06/29/82</td>
<td>12/21/82</td>
</tr>
<tr>
<td>Signing Date</td>
<td>-</td>
<td>02/04/83</td>
</tr>
<tr>
<td>Effectiveness</td>
<td>05/05/83</td>
<td>04/22/83</td>
</tr>
<tr>
<td>Completion</td>
<td>06/30/87</td>
<td>06/30/90</td>
</tr>
<tr>
<td>Closing Date</td>
<td>06/30/88</td>
<td>06/30/90</td>
</tr>
</tbody>
</table>

Staff Inputs

<table>
<thead>
<tr>
<th>Stage of Project Cycle</th>
<th>Planned</th>
<th>Revised</th>
<th>Final a</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Through appraisal</td>
<td>n.a.</td>
<td>n.a.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Appraisal through Board Approval</td>
<td>n.a.</td>
<td>n.a.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Board approval through effectiveness</td>
<td>n.a.</td>
<td>n.a.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supervision and PCR</td>
<td>77.6</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total n.a.

a. PCR estimates of staff inputs are obviously erroneous. The supervision data is taken from MIS.
### Missions

<table>
<thead>
<tr>
<th>Stages of Project cycle</th>
<th>Month /Year</th>
<th>Number of persons</th>
<th>Days in field</th>
<th>Specialization represented</th>
<th>Types of problems [Performance Rating]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identification</td>
<td>2/79</td>
<td>5</td>
<td>31</td>
<td>2 E, 3 A</td>
<td>Projects in Central Myanmar for rehabilitation of existing irrigation scheme, &amp; four possible new schemes based on storage in Yin valley were identified. Government started preparation of both rehabilitation &amp; new projects.</td>
</tr>
<tr>
<td>Preparation (1)</td>
<td>9/79</td>
<td>1</td>
<td>10</td>
<td>E</td>
<td>ID design capacity, opposition to ICB for vehicles, &amp; hydrology were main problems. Only one project (Kinnimundaung) prepared.</td>
</tr>
<tr>
<td>Preparation (3)</td>
<td>6/7/80</td>
<td>5</td>
<td>13</td>
<td>2 E, 2 Ec, DC</td>
<td>Hydrology &amp; water management at Kinnimundaung still a problem. Government gave up preparation of other new projects in central Myanmar &amp; gave priority to projects in Tennasserim area.</td>
</tr>
<tr>
<td>Preparation (4)</td>
<td>1/8/1</td>
<td>6</td>
<td>20</td>
<td>3 E, H, SE, A</td>
<td>Hydrology of both Kinnimundaung (Central Myanmar) &amp; Azin (Tennasserim) examined in detail, soils studied &amp; project planning advanced.</td>
</tr>
<tr>
<td>Preparation (5)</td>
<td>3/8/1</td>
<td>1</td>
<td>5</td>
<td>E</td>
<td>Kinnimundaung &amp; Azin selected for implementation.</td>
</tr>
<tr>
<td>Preparation (6)</td>
<td>5/6/81</td>
<td>4</td>
<td>9</td>
<td>4 E</td>
<td>Hydrology examined again.</td>
</tr>
<tr>
<td>Preparation (7)</td>
<td>8/81</td>
<td>1</td>
<td>8</td>
<td>E</td>
<td>Layout for Kinnimundaung &amp; Azin Dams finalized. Use of Azin storage for water supply to Moulmein town actively considered.</td>
</tr>
<tr>
<td>Appraisal</td>
<td>11,12/81</td>
<td>7</td>
<td>2</td>
<td>2 E, 4 E, 1 A</td>
<td>Sub-project for lending finally selected as Kinnimundaung for 5,000 acres, Azin sub-project for Moulmein town Water Supply, development of orchards in 850 acres, &amp; paddy irrigation 2,000 acres.</td>
</tr>
<tr>
<td>Post Appraisal /Supervision (1)</td>
<td>2/3/82</td>
<td>4</td>
<td>9</td>
<td>3 E, 1 Ec</td>
<td>The procedures for procurement of goods taking time. Local factories unable to supply items, reserved for local procurement. [2/4]</td>
</tr>
<tr>
<td>Supervision (2)</td>
<td>3/8/3</td>
<td>1</td>
<td>18</td>
<td>Ec</td>
<td>Participated in dam expert review.</td>
</tr>
<tr>
<td>Supervision (3)</td>
<td>4/83</td>
<td>1</td>
<td>10</td>
<td>E</td>
<td>Reviewed designs of water supply component.</td>
</tr>
<tr>
<td>Supervision (4)</td>
<td>5/8/3</td>
<td>2</td>
<td>7</td>
<td>E</td>
<td>Procurement delays resulted in losing one season. Delay in recruitment of consultants for: (i) water supply review; &amp; (ii) design &amp; planning; delay in initiating base agroeconomic surveys &amp; overseas training. Changes necessary for reserve procurement. [2/4]</td>
</tr>
<tr>
<td>Supervision (5)</td>
<td>11,12/83</td>
<td>3</td>
<td>19</td>
<td>2 E, 1 Ec</td>
<td>Review by Division Chief &amp; Irrigation advisor.</td>
</tr>
<tr>
<td>Supervision (6)</td>
<td>2/8/4</td>
<td>2</td>
<td>8</td>
<td>Ec, E</td>
<td>Poor delivery of reserve procurement. Government decision for ICB instead. Project one year delay. [2/1]</td>
</tr>
<tr>
<td>Supervision (7)</td>
<td>5/6/84</td>
<td>3</td>
<td>16</td>
<td>2 E, 1 Ec</td>
<td>Timely supply of diesel, cement, &amp; reinforcement doubtful; delivery of jeeps under reserve procurement &amp; processing for overseas training of MAS staff delayed. [2/1]</td>
</tr>
<tr>
<td>Supervision (8)</td>
<td>10/84</td>
<td>1</td>
<td>6</td>
<td>Ec</td>
<td>Cost recovery for Mudon water supply, facilities for repair of meters, provision of sufficient operation staff, &amp; setting up proper accounting procedures.</td>
</tr>
<tr>
<td>Supervision (9)</td>
<td>11,12/84</td>
<td>1</td>
<td>5</td>
<td>FA</td>
<td>Delay in submission of withdrawal applications, shortage of reinforcement steel &amp; cement, continued delay in overseas training of MAS &amp; ID staff. [2/1]</td>
</tr>
<tr>
<td>Supervision (10)</td>
<td>3/8/5</td>
<td>4</td>
<td>20</td>
<td>E, 2 Ec, AD</td>
<td>Improvement needed in quality &amp; alignment control, shortage of staff in planning &amp; design. Training of MAS not yet started, MAS did not post full staff for extension &amp; trials. Construction materials &amp; diesel oil shortage. Delay in submission of audit reports. No progress on water supply component of planning for water management. [1/1/1/1]</td>
</tr>
<tr>
<td>Supervision (11)</td>
<td>11,12/85</td>
<td>3</td>
<td>17</td>
<td>2 Ec, 1 E</td>
<td>Quality control to be done by non CC staff, selection &amp; training of MTDC staff to be expedited. Accuracy of detailed designs to be assured, decision on tariffs for water supply to be taken.</td>
</tr>
<tr>
<td>Supervision (12)</td>
<td>3/8/6</td>
<td>1</td>
<td>8</td>
<td>E</td>
<td>Shortage of diesel &amp; construction materials affecting work; Agriculture support staff not posted fully by MAS; MAS overseas training not commenced, Audit reports overdue. [1/1/1/1]</td>
</tr>
<tr>
<td>Supervision (13)</td>
<td>4/5/86</td>
<td>3</td>
<td>19</td>
<td>E, Ec, En</td>
<td>Acute shortage of diesel, no action on improving water management, training of MAS staff not started, Audit reports overdue. [1/1/1/1]</td>
</tr>
<tr>
<td>Supervision (14)</td>
<td>11,12/86</td>
<td>3</td>
<td>18</td>
<td>E, FA, A</td>
<td>Training of MTDC staff for water supply not started; testing of water supply pipelines to be carried out; detailed drawings to expedited; works behind schedule; &amp; accounting procedures to be set up for drinking water supply.</td>
</tr>
<tr>
<td>Supervision (15)</td>
<td>3/8/7</td>
<td>2</td>
<td>8</td>
<td>E, FA</td>
<td>Acute shortage of diesel, MAS staff training not started; training for water management not commenced. [1/1/1/1]</td>
</tr>
<tr>
<td>Supervision (16)</td>
<td>5/8/7</td>
<td>1</td>
<td>15</td>
<td>E</td>
<td>Acute shortage of diesel. Though GOM agreed to import crude oil, delay in procurement likely; water management efforts insufficient. [1/1/1/2]</td>
</tr>
<tr>
<td>Supervision (17)</td>
<td>11,12/87</td>
<td>3</td>
<td>21</td>
<td>E, A, DC</td>
<td>Minimum water charge for house connection high; need for surge protection vessel; MTDC staff training not started.</td>
</tr>
<tr>
<td>Supervision (18)</td>
<td>2/3/88</td>
<td>1</td>
<td>8</td>
<td>E</td>
<td>Progress on water management insufficient, water supply works affected by cement shortage, land allocation for orchards not started, extension activity for new crops weak. [1/1/1/1]</td>
</tr>
<tr>
<td>Supervision (19)</td>
<td>3/8/9</td>
<td>1</td>
<td>13</td>
<td>E</td>
<td>Water supply works need push; credit still not available to orchard growers, progress on water management slow. [1/1/1/1]</td>
</tr>
<tr>
<td>Supervision (20)</td>
<td>5/8/9</td>
<td>1</td>
<td>13</td>
<td>E, A</td>
<td>Credit still not available to orchard growers; progress on water management slow. [1/1/1/1]</td>
</tr>
<tr>
<td>Supervision (21)</td>
<td>12/8/9</td>
<td>2</td>
<td>10</td>
<td>E</td>
<td>Moulmein town water supply not commenced. [1/1/1/1]</td>
</tr>
<tr>
<td>PCR</td>
<td>5/9/0</td>
<td>1</td>
<td>14</td>
<td>E</td>
<td>Moulmein town water supply not commenced. [1/1/1/1]</td>
</tr>
</tbody>
</table>


Note: Days in field are for total duration of the missions, when more than one project was reviewed. It is not possible to separate the days attributable to Tank Irrigation Project.
Evaluation Summary

1. OED audited this project as part of a regional impact study of irrigation and drainage projects in South and South East Asia. The project included one tank site in each of two zones, and was to be the first in a series of multiple tank projects supported by the Bank. Changes in political conditions in Myanmar in 1988 brought the processing of all further Bank projects to a halt.

Project Objectives and Preparation

2. The main objective was to increase crop production and farm incomes through construction of storage dams and irrigation facilities. Technical assistance was included to strengthen the capacity of the Irrigation Department (ID) to plan and execute similar projects. Support was given as well for expanded research and extension services provided by the Myanmar Agricultural Service (MAS). The targeted populations were small farms growing paddy and other field crops and orchards. The project was to also improve health standards of a town near one of the tank sites, by providing the municipality with a piped water-supply.

3. The Kinmundaung site lies in Myanmar's central dry zone, where low and unreliable rainfall confine unirrigated agriculture to one monsoon crop, plus precarious efforts to bring to harvest dryland crops during the pre- and post-monsoon periods. The sub-project included an earth dam and reservoir, rehabilitation of an existing diversion weir, extension and remodeling of the old right and left main canals, and construction of the minor irrigation network. The system was to command about 5,000 irrigable acres. A second paddy crop was rejected as too water-intensive. A high-value crop, cotton, was proposed for the rotation to justify the scheme.

4. The Azin sub-project included an earth dam and reservoir, and construction of a main canal, two major distributaries and the minor irrigation network, all new works. The system was to command about 2,000 irrigable acres of paddy land and 850 acres of orchard on higher land. The rainfall regime is different from Kinmundaung: monsoon rainfall is adequate to sustain paddy without supplementary irrigation. The storage provided by the sub-project was to support dry season crops. Orchards were added to enhance the economic returns. The Azin sub-project also included the investment costs of the piped water system for Mudon town.

Implementation Experience

5. The main construction jobs were the two dams. Work on both started simultaneously in 1984 one year late, due to delays in procurement of equipment, and within a year further progress was crippled by a shortage of diesel fuel. Government refused at first to import. The crisis lasted nearly three years. During this period, work slowed at Kinmundaung and came almost to a halt at Azin. When sufficient fuel supplies were restored starting in mid 1988, progress at the sites responded quickly. Kinmundaung was completed in 1988, after which ID reassembled at Azin. The main works at Azin and Mudon were completed by mid-1990, three years after the original completion date. The performance at Kinmundaung, with delays of less than a year to completion, and the speed of recovery at Azin, demonstrated ID's competence to execute major works.
6. The dams were finished and met the specifications of the modified designs. Main irrigation works were also completed as planned for the 5,000 acres at Kinmundaung and 2,850 acres at Azin. Supervision reports and the PCR call the quality of works good. Farmers were responsible for construction of the smaller canals, leading to individual fields, and ditches both within those fields and leading to lower fields not adjacent to the main network. The pace of construction and the quality of these works were below expectations. The claim that the project was "completed" in 1990 disregards the fact that the largest component of the canal system was, then, still incomplete.

7. A small team of Australians arrived a year late to initiate the technical assistance contract with ID. Nevertheless, the consultancy was well managed, rapport with ID was excellent, and efforts at institutional "training" appear to have been uniformly successful. Performance of the MAS component was also generally good. The construction or expansion of facilities at three research/demonstration farms was completed on schedule, and technical work performed on the farms was praised by supervision missions. The MAS contribution was weakest in the farmers' fields at Kinmundaung, where it was required to provide farmer advisory services to support the new water management and cropping systems. In the late 1980s, though the supervision ratings for "development impact" continued to be set at an optimistic "1," the supervision narrative alerted the Bank to the possibility of a substantial reduction (from the SAR projections) in the incremental cropped area.

Outcome

8. The two sub-projects were technically uncomplicated and completed largely as planned. The Kinmundaung irrigation system appears to have been substantially overbuilt, vis-à-vis the water supply in storage, and the agricultural impact will be much less than anticipated. Conversely, to date the Azin system has an aura of success, with abundant water, good paddy crops and reasonably well maintained orchards that are maturing on schedule. The management of the water in the canals and fields has not been fully effective at either site, but that is a problem only at Kinmundaung. ID and the farmers have outperformed their counterparts, in other countries included in OED's regional impact study, in the maintenance of the canals and ditches. However, farmers at Kinmundaung did not adopt the advanced cropping systems anticipated during preparation, and farmers at Azin have shown no interest in diversification either.

9. Rates of return were re-estimated for the sub-projects based on the ERR analytical framework in the SAR. In Kinmundaung, a sharp reduction, by about 60 percent, in cropping intensity causes a substantial decrease in output. This loss is compounded by the collapse in the price of rice below SAR projections, also by about 60 percent. The recomputed ERR for Kinmundaung is negative (the SAR estimate was 13.6 percent). For the Azin subproject there is no reduction for cropping intensity, since performance meets the SAR target. However the ERR is also affected by the decline in the international price of rice. OED recalculates the ERR for the Azin investments, including the Mudon town water supply component, at six percent (the SAR estimate was 12.3 percent).

10. The infrastructure of the Mudon water supply system is in place and capable of meeting the delivery and quality standards set. However, demand for the water is only about 15% of the expected level and shows no sign of rapid growth.
Sustainability

11. Sustainability of the reduced benefit stream at Kinmundaung, the full benefit stream at Azin, and the institutional progress at the Irrigation Department seems assured. O&M performance by ID and the irrigators is adequate to keep the water flowing, and ID has gone on to plan and implement many other operations of larger and smaller size than these two tanks. There is no indication of a deterioration in the quality of its planning skills.

Findings and Lessons

12. Tank I as a Pilot Project. The Tank Project was conceived as the first of a series of projects providing Bank support for the creation of irrigation capacity at medium-size storage sites. Despite the construction delays, and the water shortage at Kinmundaung, as a pilot it was a success. It demonstrated ID's competence to complete the schemes to design specifications, while enhancing ID's capacity to carry out the whole operation to high standards without requiring external technical assistance.

13. Operations and Maintenance. The OED impact study team gave priority to O&M issues, which are elaborated in the impact study report. ID's performance, with government's financial support, stands out in the regional study of O&M. One notable feature at the Myanmar sites is the way farmer labor is mobilized to help ID clean the main canals. This is uncompensated labor, and all farmers in the villages receiving irrigation, whether their farms get water or not, participate. The tradition of farmer support for the cleaning (and some repair) of irrigation superstructure is rooted in Burmese culture.

14. The main gap in O&M at Kinmundaung is the lack of control of water distribution below the main distributary turnoffs. The project-installed gates are missing, and the substitute, farmer-made blocks of cloth, earth and banana stalks are not used to do the main job the controls were intended to do—enforce a rotation that would deprive upstream farmers of continuous delivery. This shows up as a maintenance problem, in damaged, dysfunctional or missing gates. But it is fundamentally an operational problem, because of the lack of respect for planned rotations and improved water management. This "maintenance" problem is not evident at Azin, because water is abundant there.

15. Cropping Patterns. Another disappointing feature on the operational side of this project is the failure of the farmers to advance to more diversified and profitable cropping systems. The driving force behind this reform, as projected at appraisal, was the low international price of rice. The paddy crops by themselves could not provide the economic returns needed to offset the construction costs. The financial returns to paddy might be attractive to farmers; the economic returns would not be attractive to Myanmar. Other crops were introduced in the plans at both sites to justify the investments. Wherever they were intended to replace paddy, they were not accepted.

16. Ratings. The project outcome is rated satisfactory as a pilot activity, despite the poor economic returns to the Kinmundaung sub-project. These were the first substantial works involving dam construction carried out almost entirely by ID engineers using force account. The project established and confirmed ID's capacity for subsequent works, which it has exploited impressively in the last five years. ID's overall performance, with fine support from the consultants, indicates substantial institutional development and the likelihood that both the
benefits to ID and the management of available water on the schemes will be sustained. Performance by the Bank was also very satisfactory. Bank supervision maintained its professional relationship with ID despite the shortages of supplies and long delays. The Bank chose not to suspend disbursements, and the ultimate results in terms of the construction program justified that confidence. Suspension would have been counterproductive.
1. **Introduction**

1.1 OED selected this project for audit in order to include it in a regional impact study of irrigation and drainage projects in South and South East Asia. The emphasis of the regional study is on the performance of operations and maintenance (O&M) services, and the influence of O&M on the sustainability of irrigation project impacts. Other projects selected for the regional study were gravity irrigation operations elsewhere in Myanmar (the Kinda Dam Multipurpose Project\(^1\)), Thailand and Vietnam. The regional impact study report has been prepared in tandem with this audit report. A comprehensive discussion of O&M issues, of the role of farmer water-user groups, and of agro-economic impacts associated with the audited project is provided in the Myanmar component of the impact study. Those findings are summarized in this audit report.

1.2 The Tank Irrigation Project was the fifth in a series of Bank-supported operations in Myanmar for irrigation, flood control and drainage, starting in 1974. The first three concentrated on minor irrigation and flood control in the delta ("Lower Burma"). The fourth was for constructing the Kinda Dam and associated power and irrigation works on the Panlaung River in the dry zone ("Upper Burma"). The Kinda Dam Project was appraised in FY76 and approved in FY80. During that period in the late 1970s the Bank, with support from FAO/CP, reviewed several other possible interventions in the irrigation sector, including new starts with substantial dams and diversion works, rehabilitation of older large schemes, and proposals for a group of medium-size dam (tank) projects in the dry zone. Subsequently, attention was directed as well to potential tank sites in the coastal zone of Mon State, south of Moulmein. The project under audit included one tank site in each of the two zones, and was intended to be the first in a series of multiple tank projects supported by the Bank in a time-slice progression. Tank II was appraised in 1988. But changes in political conditions in Myanmar later that year brought the processing of all further Bank projects to a halt, and no other irrigation projects have been or are currently being considered.

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1. Kinda (Nyaunggyat) Dam Multipurpose Project (Cr. 1031-BA; approved FY80).
2. **Project Objectives And Preparation**

A. Objectives

2.1 The main objective was to increase crop production and farm incomes through construction of storage dams and new irrigation facilities. Technical assistance was included in this pilot program to strengthen the capacity of the Irrigation Department (ID), of the Ministry of Agriculture and Forest, to plan and execute similar projects. The targeted populations were small farms growing paddy and other field crops and orchards. The project was to also improve health standards of a town, near one of the tank sites, by providing the municipality with a piped water-supply.

B. Preparation

2.2 The project was prepared by ID with frequent visits by FAO/CP and Bank staff. Preparation work started with investigations of four sites in near proximity in the Yin basin of Magwe Division. The feasibility study and design for the Kinmundaung site was the most advanced when, in 1980, government shifted attention to another cluster of sites in Mon State. Further work on the other Yin sites was deferred, and preparation of the Azin sub-project in Mon was accelerated to provide the Bank a package of two sub-projects for appraisal.

2.3 The Kinmundaung area lay in the middle of the dry zone, where low and unreliable rainfall confined unirrigated agriculture primarily to one monsoon crop, plus precarious efforts to bring to harvest dryland crops during the pre- and post-monsoon periods. Without supplementary irrigation a paddy crop during the monsoon season was also precarious, because of frequent failure of the late rains. Sesame, groundnuts, and other oil-seeds (Magwe Division is the center of oilseed production in the country), and other crops with lower moisture requirements than paddy, performed well in the monsoon season, and reasonably well in the pre-monsoon and post-monsoon seasons in about half the years. Cropping was impossible in the four, dry "summer" months December through March. The area of the Yin basin under study was favored with good soils and a topography that provides occasional sites for storage on rivers, of relatively limited natural catchment area, running westward from the Pegu Yoma hills toward the Yin River and on to the Irrawaddy.

2.4 In other parts of the dry zone farmers for thousands of years had been successfully irrigating fields from waters diverted through canals from large, perennial rivers flowing to the Irrawaddy. These run-of-the-river gravity irrigation schemes were the foundation of the Burmese civilization. The Panlaung River system was one of the oldest and most important sources supplying the granaries of the ancient dynasties. In the Yin basin, however, there were few schemes of any significance. Kinmundaung was one of them. British engineers had rebuilt the earlier irrigation works on that river in 1911. But in the intervening years the canals had silted, the infrastructure had deteriorated, and by 1980 only about 400 ha were still receiving supplementary wet season irrigation with any regularity. Thus, a large majority of the farmers to be incorporated in the 2,000 ha scheme planned by ID had no previous experience with gravity flow irrigation, apart from watering their gardens from shallow dug wells.
2.5  The Kinmundaung sub-project was to include a 25 meter-high earth dam, a reservoir fed from about 74 sq. kilometers of catchment, rehabilitation of an existing diversion weir six kilometers below the dam on the Kinmundaung River, extension and remodeling of the right and left main canals, and construction of the minor irrigation network. The system as finally specified was to command about 5,000 irrigable acres (2,100 ha, see Map 1). The storage capacity was expected to provide supplementary irrigation for the monsoon crop for all 5,000 acres, including 3,000 acres of paddy and 2,000 acres of other field crops (cotton and sunflower were proposed in the Staff Appraisal Report). It was also expected to support 1,500 acres of pre-monsoon sesame and up to 1,000 acres of post-monsoon groundnuts. Average farm holdings of irrigable land was about 5 acres, and 1,100 farmers would participate.

2.6  The proposed cropping pattern was subject to extended debate during the preparation and appraisal periods. The Bank and ID recognized that the size of the catchment and anticipated inflow to the reservoir were too small to both guarantee a paddy crop for the whole command area of 5,000 acres during the monsoon season, as well as leave water in storage to support extensive dry season cropping. Even by rationing monsoon irrigation to paddy in the lowlands, and to other crops on the higher fields, the residual storage in years of normal rainfall would support full irrigation of off-season crops in only half of the command area. A water-intensive second paddy crop was rejected, in favor of spreading whatever water was available over a larger area. The Staff Appraisal Report (SAR) considered 1,500 acres of sesame as a safe target in its indicative program, and added up to 1,000 more acres of groundnut depending on the residual storage in any given year. The seasonality of off-season irrigation was under dispute. If retained beyond the post-monsoon planting period, the pool of stored water would decrease due to evaporation from the reservoir. Nevertheless, sesame planted in the next year's pre-monsoon season was favored over groundnuts planted immediately following the monsoon. The crops were also debated. The economic viability of the scheme investments was known to be marginal in any case, and the preparation and appraisal teams felt obliged to include a high-value crop component, in this case cotton, to fully justify the scheme, despite the fact that cotton was new to the area, that it would require a substantial advance in husbandry standards, and that the Bank's Agriculture and Rural Development Department (AGR) warned at the beginning that using cotton to rescue the economic analysis was risky. The SAR did not include any provision for irrigation of a crop planted in the driest, summer season. As discussed below, most of these projections proved to be wrong.

2.7  The Azin site was one of a cluster of ten potential tank sites strung out in a 20 km line north and south of the town of Mudon. The area comprises a corridor of land bounded by the Taungnyo hills to the east and the Salween River estuary to the west. The area is divided into three principal land forms: the Taungnyo hills, the piedmont fan and the estuarine flood plain. The area grows rain-fed paddy on the flood plain, while the piedmont fan is cultivated with rubber (mostly government estates), and orchards (all private), the latter in small gardens irrigated from shallow wells. The tank sites were on the streams as they left the hills. Stored water was to be made available to the perennial tree crops on the piedmont and/or the paddy down on the plains. Plans for Azin were advanced in preference to the other sites, even though

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2. At this point, the PAR text switches from hectares to acres for scheme and farm sizes, the common measure of all reporting on these areas in Myanmar and the Bank's reports.

3. The SAR used the full 2,500 acre second crop projection in the rate of return calculations, recognizing that to be the upper limit of the probable range.
the command area was much smaller than (twenty percent the size of) the largest alternatives. 
This was to be the first tank built by ID on the southern coast.

2.8 The Azin sub-project would include a 28 meter-high earth dam, a reservoir fed from about 6 sq. kilometers of catchment, and construction of a main canal, two major distributaries and the minor irrigation network. The system as specified was to command about 2,000 irrigable acres (800 ha) of paddy land and 850 acres (350 ha) of orchard (Map 2). The rainfall regime was completely different from Kinmundaung. The small catchment area, and geography at the dam site, were the limiting constraints, not the rainfall. Monsoon rainfall was adequate to sustain paddy without supplementary irrigation (except perhaps for nurseries). The storage was intended to support dry season crops, including a second paddy crop throughout the lowland command if that was indicated. In fact the cropping pattern for Azin was also debated. It could be shown here as well that the economics of a second paddy crop would not in itself justify the investment. Initial plans did not include irrigation for orchards in the uplands. Orchards were added to enhance the economic returns. Doubts were expressed about the marketability of the fruit, but the issue was not as contentious in the Bank as the cotton proposed for Kinmundaung. The orchard component was considered a pilot, opening the way to similar orchard/paddy combinations in future tanks. The Bank also considered alternatives to planting paddy exclusively on the 2,000 acres during the dry season. Ultimately, the SAR committed all the lowland area to a second paddy crop. The 2,000 acres were expected to be farmed by about 450 families, averaging under five irrigable acres each. The irrigated orchard land would be divided between a state farm of 250 acres and 150 individual holdings averaging four acres each (totaling 600 acres).

2.9 The Azin subproject also included investments in a piped water system for Mudon town, which at the time had no municipal supply and relied on individual householders' shallow dug wells and local streams. At first the project plans had provided for piping water to the larger city of Moulmein (population 200,000), 35 km to the north of Mudon (population 40,000). But other sources of funds and water for Moulmein were identified just before the Bank's appraisal mission, and the Bank persuaded a reluctant government to redirect the water supply component to Mudon. The demand on the reservoir was smaller, and the Bank and government agreed to reserve ten percent of available water for the town. The project would finance a water treatment plant at the dam site, pumps and a pipeline to the town center 2 km away, a storage tower, and a distribution system within the town providing both street standposts and connections to individual properties. About 140 standposts and 1,700 household connections were projected for the completion date in 1986, the number of private connections expanding to 2,500 by the year 2,001. It was reckoned that demand would grow to 1.4 million gallons per day (mgpd) by that year. Tests had shown that the rate of gastrointestinal disease was twice as high in Mudon as the national average, and that polluted wells were the primary source. There was little debate about the need for piped, potable water; the discussion at appraisal was about an appropriate consumer pricing plan to cover the costs of the infrastructure and operating expenses. Government agreed to full cost recovery. Households would arrange and pay for piping into, and facilities within, the buildings, and pay also a monthly water charge based on use.

2.10 The project included support for expanded research and extension services provided by the Agricultural Corporation, later renamed the Myanma Agricultural Service (MAS). ID and MAS are both under the same Ministry. Project funds would allow MAS to construct a new, 50 acre research/demonstration farm within the Kinmundaung command area, and to expand facilities and staff at two existing research stations, near the Azin site, at the time dedicated to
horticulture and perennial crops. The SAR emphasized the importance of these backup services in securing the proposed new cropping systems, for example for the introduction of cotton and the establishment and care of four-acre orchards, and for efficient use of irrigation water. The 250 acre state orchard, managed by MAS, was described as a pioneer enterprise and nucleus for the private plantations and their inexperienced owners. MAS had already demonstrated an ability to manage large farms successfully. Funds were allocated for local and overseas training of MAS staff.

2.11 Finally, the project provided for institutional support for ID. The major component would finance a contract for technical assistance (TA) from an overseas firm to be attached to ID's Planning and Design Division. The TA would help the Division to: (1) upgrade its planning and monitoring skills across the board, (2) prepare one or more new gravity irrigation sub-projects for the Tank II project, (3) prepare detailed designs for a major sluice structure for a proposed paddylands project in the delta, and (4) organize a training program for ID staff.
3. Project Implementation

3.1 The main construction jobs were the two dams. Work on both started simultaneously in 1984 one year late, due to delays in procurement of equipment. The monsoon limited the number of months available for these works, especially at Azin. Also, a visiting consultant engineer altered initial design of the dam, spillway and other structures at both sites. After start-up of physical works, progress was kept close to the revised schedule for over a year. Supplies of certain key construction materials, principally cement and reinforced steel were short. But the Bank agreed to amend the legal documents to permit the finance of reinforced steel rod imports and with that and other aggressive acquisition programs ID managed to keep the two irrigation jobs and the water supply system on pace. The Irrigation Department was responsible for supplying materials for constructing the water supply system, while the Construction Corporation, of the Ministry of Construction, built it.

3.2 Late in 1985 progress was crippled by an unanticipated shortage of diesel fuel. Government had planned to rely on domestic production, but a nation-wide deficit forced government to ration available supplies. Government refused at first to import. The fuel crisis lasted almost three years, until government in late 1987 agreed to the use of project foreign exchange to import crude oil for Tank I (and other development projects), and the subsequent procurement arrangements were concluded. During this period, work slowed at Kinmundaung and came almost to a halt at Azin. ID decided to concentrate the fuel ration and equipment at Kinmundaung, to complete that job as close to schedule as possible (partly to avoid high default penalties to contractors). The two year delay at the Azin dam site partly explains comparable delays in constructing the Mudon water supply system. Those works were less constrained than the dams by the fuel shortage, and the main limiting factor there was the efficiency of the Construction Corporation and the Mudon Township Development Committee (MTDC). In its December 1986 report, Bank supervision downgraded the project to a "3" rating (serious problems that are being addressed), and it stayed at that level for over a year.

3.3 When sufficient fuel supplies were restored starting in mid-1988, progress at the sites responded quickly. Kinmundaung was completed in 1988, after which ID reassembled in strength at Azin. The main project works at Azin and Mudon were completed by mid-1990, three years after the original completion date (and two after the original closing date). Actual total costs were US$30.8 million, 14 percent above the appraisal projection, and the Bank disbursed US$17.7 million (SDR 15.1 million), 84 percent of the agreed amount. Of that, US$0.9 million was for petroleum products, another category introduced subsequent to signing the Credit. The project was closed on June 30, 1990, and SDR 2.8 million was canceled four months later.

3.4 The delay in works under the Tank Project must be assessed against ID's relatively good record in construction elsewhere. The two-and-a-half year interruption starting in late 1985 was exceptional. The main problem was the fuel. As mentioned above, ID was able to keep up (barely) with requirements for cement and reinforced steel, with the help of a reallocation of Bank funds. Government's reluctance to import any crude oil, whether or not the foreign exchange was available, affected all projects, Bank and others, including construction at Kinda.

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4. Although if fuel supplies had not been short, the supply of these other products may have emerged as serious constraints to implementation.
The PCR attributes the delays in part to the low priority which government gave to the tanks, at
least the one at Azin. The PCR recommends the Bank protect itself in subsequent projects by
getting firmer commitments to, and penalties to protect, the work schedule, and be prepared to
suspend disbursements in the face of a continuing refusal to guarantee essential materials. In this
case, the audit feels that such actions would have been counterproductive. It was partly because
of the persistence of the PCR author himself during this period of supervision, and government's
respect for him and the Bank, that the policy was eventually relaxed. Threats of suspension
would have been unlikely to have helped. The performance at Kinmundaung, with delays of less
than a year to completion, and the speed of recovery at Azin, demonstrate ID's competence in
execution of major works. Delays in other countries are often best explained by factors within
the control of project management. That was not the case for Tank I.

3.5 The uneven progress of construction is reflected in the pattern of ratings set by
successive Bank supervision missions. Ratings on most management-influenced indicators
remain at the "1" level throughout the project history. The only indicator rating that drops to a
"3" is the most important one, for overall performance, which picks up the impact of the fuel
shortage and government's decisions on rationing. The rest of the ratings follow the narrative of
the reports, where it is clear that Bank staff are impressed by and sympathetic with an ID staff
trying hard to perform to standards under adverse conditions. Ex post, overall ratings of Bank
and ID performance are satisfactory, and this despite a national policy on imports that disrupted
construction work on all donor-financed projects.

3.6 The dams were finished and met the specifications in the modified designs. Main
irrigation works were also completed as planned for the 5,000 acres at Kinmundaung and 2,850
acres at Azin. Supervision reports and the PCR call the quality of works very good.

3.7 Farmers were responsible for construction of the smaller canals, leading to individual
fields, and ditches both within those fields and leading to lower fields not adjacent to the main
network. The pace of construction and the quality of these works were below expectations. At
both Kinmundaung and Azin ID had to enter the fields in subsequent years to help MAS
motivate the farmers to accelerate and upgrade the works. As the field networks reached
completion, and the first releases of water were made at both sites, supervision reports began to
criticize the fact that the gates and other control devices that should have been installed to
support the required rotations and promote improved water management at the field level were
not in place, either at the turnoffs from the secondary distributaries or at the head of the
watercourses. The claim that the project was "completed" in 1990 disregards the fact that the
largest components of the two canal systems were still incomplete and the structures in place
were of questionable quality.

3.8 The Irrigation Department started filling the Kinmundaung reservoir during the 1986
monsoon, and the first release of water into the canals was made later that season to provide at
least one irrigation to over 3,000 acres of paddy. The headworks had not been finished, but the
temporary storage was adequate to permit the limited release. As discussed below, inflows into
the reservoir have proven to be less than expected, the reservoir has never filled, and half of the
irrigable area under command has never and may never be supplied.

3.9 The initial 90 acres of MAS orchard farm at Azin were planted during 1987, and
irrigated at first with water pumped from tubewells. Practically all the individual orchards were
planted in mid-1989, along with bananas and other intercrops, and the first release of water from
the Azin dam was made soon after in sufficient quantity to secure those plantations. There are presently 187 individual orchards, up from the appraisal target of 150. Releases from the Azin reservoir for the paddy farms began in 1991, and full coverage for the 2,000 acres on the plains was achieved in 1993.

3.10 The Mudon water works were completed and the mechanical/electrical equipment and pipe network were being tested when the PCR was prepared in 1991. Subsequently the system was approved for operation, and piped water started to flow in early 1992, four years after the target date. At the time of the OED mission in June 1995, 1,723 house connections and 140 standposts had been installed, almost exactly on target. Households with connections were keeping up with the ten-year amortization schedules for repaying connection costs (even though they were not using the water, see paras. 4.3, 4.17). However, not all the households and shops had yet financed the installation of equipment to bring the water from the company connection into their buildings.

3.11 Performance of the MAS component was generally good. The construction or expansion of facilities at the three research/demonstration farms was completed on schedule, and praised by supervision missions. So was the technical work performed on the farms. The overseas training program for MAS staff was never carried out, even though MAS negotiated with one foreign private firm and, later, FAO, to handle the arrangements. The PCR says that government refused to approve the foreign training for MAS, but the files suggest the problem was due more to the character of the training initially proposed and that another proposal advanced early-on might then have succeeded. Also MAS was said to have secured other, grant sources for training. MAS' close support for developments at Azin is described below (para. 4.13).

3.12 The MAS contribution was weakest in the fields at Kinnundaung, where it was required to provide farmer advisory services to support the new water management and cropping systems. Unlike Azin, MAS performance at Kinnundaung could have a major impact on the intensity achieved in irrigated farming. MAS was not obliged to prepare its staff to meet the extension requirements of the project until shortly before the project waters were to be first released. However, in 1986 supervision reports start warning against the slow build-up of staff and the lack of any advanced training of farmers, and about the implications of both of these for the success of the operation. Though the supervision ratings for "development impact" continued to be set at an optimistic "1" (para. 3.5), the supervision narrative began to sound the alert on the possibility of substantial slippage below the projections of incremental crop areas and production.

3.13 The TA input into ID was one of the brightest parts of the project. The process of contracting a firm to support ID's Planning and Design cell took longer than expected, and the small team of Australians arrived a year later than expected. Nevertheless the consultancy was well managed, rapport with ID was excellent, and efforts at institutional "training" appear to have been uniformly successful. Unlike the experience at MAS, the overseas training program was well organized and met its targets of sending 17 ID staff in three batches to Australia for specialized short-term training lasting two to five months. The consultants were primarily responsible for preparing Tank II. They began that work with a "Ranking" study, completed in 1985, that compared the physical and economic features of all proposed remaining sites in the Yin Basin and near Mudon. This led to the selection of the Yin River dam project itself, one of the prospects in the Yin Basin. This dam and irrigation scheme, substantially larger than the two dams of Tank I, would comprise the whole of Tank II. This was the project proposal that was
appraised by the Bank in 1988 but abandoned after relations with Myanmar soured. The Yin Project was completed by ID in 1995 using government funds.

3.14 The two tanks did not require any involuntary resettlement. There were few structures in the areas of either reservoir, other than forestry service huts and some temporary buildings.
4. **Outcome**

A. **General Remarks**

4.1 The two sub-projects were technically uncomplicated and completed largely as planned. The Kinmundaung irrigation system appears to have been substantially overbuilt, relative to the water supply in storage. The agricultural impact will be much less than anticipated. Conversely, to date the Azin system has an aura of success, with abundant water, good paddy crops and reasonably well maintained orchards that are maturing on schedule. The management of the water in the canals and fields has not been fully effective at either site, though that is a problem only at Kinmundaung. ID and the farmers have outperformed their counterparts, in other countries included in OED's impact study, in the maintenance of the canals and ditches. Farmers at Kinmundaung did not adopt the advanced cropping systems anticipated during preparation, and farmers at Azin have shown no interest in diversification either. Nevertheless, for a pilot the outcome of the Tank Project can be rated satisfactory. Benefits to both the Irrigation Department and the farmers within the actual irrigation perimeters are sustainable. The positive impact on ID itself was substantial, as the pilot helped lead to a surge of ID construction activity in subsequent years. Agricultural impact is discussed in this chapter and the O&M and adoption issues are discussed in the next.

4.2 It should be noted up front that farmer behavior is not just a function of farmer preferences. Since the land tenure reforms of the early 1960s, the State owns all farmland. It has ultimate control, which it uses over the crops planted. Government can force farmers to grow priority crops to meet national production and/or export targets. Government also maintains a list of scheduled crops for which farmers are obliged to sell pre-specified quantities per acre to government at controlled prices. Any surplus of scheduled crops, and crops not on the list, can be sold in the market. Monsoon paddy, sesame and cotton, among other crops, are on the list; pre-monsoon paddy and fruit are not. Some outsiders associate government's interventions with the socialist regime. In fact both the planting and procurement quotas are rooted in Burmese history, starting with the kings, the royal lands, and the farmers who were obliged to work them, and are among the features that distinguish this unique society. The Burmese irrigators are highly disciplined and expect to perform communal work. This is nowhere more true than in the dry zone when the call to public service involves the use of water. Luckily for the OED impact studies, which were based partly on participatory group interviews, the discipline and intrusiveness of government does not prohibit the farmers from speaking their minds. If they did not support the instructions, they complained in the interview sessions, yet carried them out nonetheless.

4.3 The infrastructure of the Mudon water supply system is in place and capable of meeting the delivery and quality standards required. However, town demand for the water is only about 15 percent of the expected level and shows no sign of rapid growth.

B. **Kinmundaung Irrigation Scheme**

4.4 The SAR states that estimated runoff from the reservoir catchment based on records for the period from 1959-81 was 22,770 acre-feet. The expected water availability ("yield") from the
reservoir was estimated to be 16,750 acre-feet. The actual average inflow for the 1986-1994 period was only 8,759 acre-feet, about 50 percent of the expected irrigation supply, and the average release for the same period was 5,938 acre-feet, about 35 percent of the expected supply. The maximum inflow in one year was 72 percent of the expected supply. The spillway has never been topped.

4.5 As concluded in the PCR, either the annual inflow was overestimated or this has been a period of continued drought over central Myanmar. Both appear to be true. Streams with highly variable discharge are extremely difficult to gauge reliably. Preparation relied perforce on flow measurements taken at the weir, a risky source but the only data available. Bank files during preparation attest to the concern of the hydrologists to get reliable estimates, but the effort was frustrated. The error has been aggravated by the shortage of rainfall in the post-project period. ID staff claim the average rainfall from 1983 to 1994 was lower than the expected average for the area. The inflows to the Kinda reservoir have also been smaller than expected, suggesting the rainfall deficit was genuine and widespread. Nevertheless, the shortfall is much greater at Kinnmundaung and the system is clearly over-dimensioned in relation to the catchment. Cropped area projections have been cut in half.

4.6 Over the last four years on average ID has provided supplementary monsoon irrigation for about 2,500 acres, all of it dedicated to paddy. The SAR indicative plan called for 3,000 acres of paddy and 2,000 acres of cotton and sunflower. Thus, only half of the area commanded by the project infrastructure has actually received supplementary irrigation during the rainy season. In the pre-monsoon season the fraction is much less. In 1994 ID supplied 500 acres of paddy; in 1995 it supplied 314 acres of paddy and 250 acres of sesame. Had all the off-season water been applied to field crops other than paddy, the 1995 total would have been about 900 acres (paddy requires at least twice the quantity of water during the pre-monsoon season than the other common field crops, and three times as much during the monsoon season). The SAR estimate for the off-season was 1,500 acres of sesame plus up to 1,000 acres of groundnut. The SAR did not anticipate using water for paddy in the second season. The SAR indicative plan for developing a monsoon cropping system that included irrigated cotton was also frustrated. The only cotton planted in the scheme is at the research farm. The sunflower and groundnut components of the SAR rotation were also not taken up by farmers.

4.7 As long as paddy remains in the pre-monsoon cropping pattern, the intensity of land use will be commensurately lower than the potential. For 1995, the intensity of irrigated farming was about 61 percent for the design command area (5,000 acres), or 123 percent for the actual command area (2,500 acres), figures which compare with the target of 150 percent set at appraisal. MAS data for planted area in the Kinnmundaung scheme shows 5,000 acres planted for each of the last several monsoon seasons, but this includes maize, sesame, beans and other field crops that did not receive any irrigation. MAS dry season data also includes crops, for example beans, planted in the post-monsoon period that can survive without irrigation. Thus the intensity of all cropping, irrigated and rainfed, is above 100 percent, but that is not the indicator targeted in the SAR.

4.8 Most of the 5,000 acres under command were planted in the monsoon seasons before the project, though not all survived mid-season dry spells and were harvested. Of the total, 1,000 acres used to receive some water diverted from the old weir or directly from the stream downriver from the weir. Overall cropping intensity reported at appraisal was 85 percent. Incremental production attributable to project works in the wet season is limited to those crops
brought to harvest which would otherwise have failed, plus the higher yields resulting from doses of irrigation, during dry intervals in the monsoon, on crops that would have been harvested anyway. Most of the crops irrigated during the off-season, whether paddy, sesame or some other, can be counted as incremental. The monsoon benefits alone, enjoyed by about half the farmers within the scheme perimeter, are substantial. During interviews for the OED impact study, farmers within reach of the irrigation supply claimed that average paddy yields from the monsoon harvest had doubled, an increment of about 0.8 tons per acre (two tons per hectare).

4.9 The rate of return was re-estimated for the Kinmundaung sub-project. The sharp reduction of 59 percent in cropping intensity (62 vs. 150) causes a substantial decrease. This loss is compounded by the collapse in the price of rice below SAR projections, by about 60 percent. The recomputed ERR for Kinmundaung is negative. The SAR estimate was 13.6 percent. The 1991 PCR re-estimate, made in 1991, was 12.3 percent, but that was based on the assumptions that the appraisal cropping pattern and intensity would be achieved. As detailed in the impact study of these sub-projects, incremental net income per hectare per paddy crop is estimated at about US$260, also well below appraisal projections. The impact on downstream farmers who do not benefit from irrigation in either season has been neutral or negative. Those that farmed on the margin of the Kinmundaung stream at its lower end and in the past diverted some of the residual flow below the weir for wet season supplementary irrigation, and/or benefited from silt deposits after occasional flooding, have seen those benefits disappear with the closing of the stream. Not many farms have suffered these losses, and they have not been counted in the rate of return analysis.

C. Azin Irrigation Scheme

4.10 Average annual releases from the Azin reservoir during 1992-94 were 99 percent of the level projected, and an amount half the size of that regulated release was lost annually over the spillway. Adequate water has been available in storage to supply the orchards and paddy, though some moisture stress has occurred at the tail end of the watercourses. The rotation provides water two days a week to the orchards, and five days to the paddy fields (two days to each farmer), during eight months. No water is released into the main canal during the monsoon. Against the SAR target of 850 acres of orchard, an estimated 838 are presently under irrigation, including all 250 on the state farm. The acreage of paddy benefiting from irrigation has grown steadily since the first release to the lowlands was made in 1991. In the 1994/95 dry season, 1,914 acres of paddy were fully irrigated. The total is expected to reach the scheme potential of 2,000 acres this year, as the last farmers dig their ditches and enter the network.

4.11 Summer season paddy yields are about as high as expected, ranging between three and five tons/ha (60-100 baskets/acre). MAS uses an average of 1.7 tons/acre (80 baskets/acre, or 4 tons/ha), in its reports, which compares with the SAR projection of 1.8 tons/acre. Such figures are consistent with the OED impact interviews. This is all incremental production attributable to the project. Nothing was planted on these fields in the dry season before the project. The private orchards, comprising varying mixtures of mango, durian, pomelo and other fruit, appear to be maturing on schedule. Planted in 1989, the first fruit were harvested in 1994. Full maturity will not be reached for all trees until 2009. Although the plantations have many vacancies,

5. Paddy yields in the monsoon season have also increased. The SAR and PCR attribute this partly to the project. That is not the case.
supposedly these are being or will be filled by replacements. MAS now reckons that farmers will easily reach the SAR yield projections for durian and pomelo, but that the mango estimates were exaggerated and the potential is about half the SAR figure. None of the 187 farmers have had prior experience with orchards of this size (4 acres), and the Azin project was seen as a pilot for subsequent irrigation schemes in this part of the country. MAS is satisfied that the experiment has succeeded.

4.12 These projections of fruit production, although reasonable and consistent with MAS expectations, may prove to be over-optimistic. The orchard program started badly because the parastatal bank that government had agreed would provide term credit to support the plantings (and to support households during the trees' immature period, to the extent that intercrops did not meet all their needs), never did so. All of the private plantations were self-financed, apart from a subsidy on the seedlings. The quality of the plantings was thus put in jeopardy, because of the low financial resources of most of the growers, although MAS believes that threat was overcome by other arrangements. For its part, MAS had agreed to conduct a study of the export prospects of these fruits, to make the case for future tank projects on this coast. The study was never carried out, which helps explain why ID has not built any more tanks in the area. The fact that fruit prices have been rising rapidly in domestic markets in the last five years has given MAS confidence that the fears at appraisal that those markets would be quickly saturated were unwarranted. Nevertheless, the harvest has just begun, and the real test of marketability on domestic markets is yet to come.

4.13 MAS support for the Azin scheme has been remarkable. This is the showcase for MAS activity in Mon State, and the intensity of extension activity has been very high. That attention has paid off with the full development of both the paddy and orchard components. MAS is currently preparing for a high-yielding demonstration within the paddy perimeter, having selected a block of 500 acres for improved husbandry and water management and the planting of a third crop comprising sesame and cow-pea at the end of the dry season. If the extra rotation is adopted by the farmers in the block, it will raise cropping intensities in the Azin scheme from 200 percent post-project to 225 percent, an additional benefit not anticipated at appraisal. In the orchards, MAS supplied the seedlings and was closely involved with establishment and, now, maintenance of the plantations.

4.14 Rates of return have been re-estimated for the Azin subproject, as with Kinmundaung, based on the analytical framework in the SAR. There is no reduction necessary for cropping intensity, where performance meets the SAR target. However the ERR is affected by the decline in the international price of rice. OED recalculates the ERR for the Azin investments, including the Mudon town water supply component, at six percent. The SAR estimate was 12.3 percent. The PCR re-estimate was 7.3 percent, reflecting the first dramatic phase of the rice-price collapse and higher orchard investment and operating costs. If the dam had been completed and the water released on schedule three years earlier, OED’s re-estimated ERR would have been marginally higher, at 8 percent. If the rice price had not declined, the ERR would have been 11 percent.

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6. The Mudon water supply benefit stream was adjusted to reflect the very slow buildup in demand for household and standpipe supplies. See para. 4.44. The PCR was prepared before the shortfall in demand appeared.
D. Mudon Water Supply

4.15 The infrastructure was completed as planned. There is of course adequate water in the reservoir to supply the town throughout the year. The power supply to the pumps is on the regional grid, yet suffers from frequent shortages, limiting the periods when the pumps can operate. But this problem is irrelevant given the unexpected shortfall in consumer demand for the water, especially at the household connections.

4.16 The reasons for the shortfall are not clear. The OED audit mission had not anticipated this phenomenon, and devoted little time to a review of the town water supply system. The problem is not the cost to the consumer. MTDC, which owns and operates the system starting at the treatment plant at dam site, charges 1 kwat (1 US cent) per 100 gallons to connected customers. This is a third of the price agreed at appraisal, which approximated average charges elsewhere in the South Asia region. ID claims that, due to the establishment of the reservoir, the water table in the vicinity of the town has risen, giving townspeople better access to groundwater through the wells sunk on individual lots. The mission visited three sites, each with a well and a connection to the township system. Houses and shops with connections are likely to have storage tanks above the building, though for most of the year they bring the well water directly to the back porch and interior facilities. Whether total consumption per capita already reaches rates projected at appraisal, and the shortfall in demand for the municipal system is fully compensated by supplies from the wells and adjacent streams, is not known.

4.17 In any case the investment has clearly not lived up to expectations. MTDC told the mission that an energetic promotional campaign might raise piped consumption from the present level of 0.15 to .20 mgpd, and that the gradual growth in the number of connections that is occurring naturally would push that figure further up. But that is still far short of the SAR target of 1.4 mgpd by 2,001 (or about 1.0 mgpd by project completion). Since the latter figure is consistent with experience with normal consumption patterns elsewhere, the explanation for the persistent shortfall in use of piped water obviously lies with the continued preference for well water. Whether the level of contamination of the wells has fallen since appraisal, removing the urgency of switching to the piped system, is not known. The government had agreed reluctantly to the Bank's proposal to switch from Moulmein to Mudon. A senior official at ID told the OED mission that the shortfall in demand is not surprising. The mission could not follow up on that comment, which suggests possible misidentification of the Mudon component.

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7. The PCR, written in 1991, reports daily use then of .26 mgpd, more than at present. This suggests usage has actually fallen in recent years, a trend that on the surface seems inconsistent with the gradual growth in number of connections. However, if piped water is used primarily for emergencies, as appears to be the case, the contrary trends can be reconciled.
5. **Findings and Lessons**

5.1 *Tank I as a Pilot Project.* The Tank Project was conceived as the first of a series of projects providing Bank support for the creation of irrigation capacity at medium-size storage sites. Despite the construction delays, and the water shortage at Kinmundaung, the pilot was a success. These were the first substantial works involving dam construction carried out almost entirely by ID's engineers using force account. The Bank was preparing to help finance a follow-on project at the Yin valley site in the dry zone when Bank/country relations broke down in 1988. The Bank and government had already agreed to defer any further site development in the Mudon area, until the marketability of the fruits on the overseas market has been assessed. Nevertheless Tank I demonstrated ID's competence to complete the schemes to design specifications, while enhancing ID's capacity to carry out the whole operation to high standards without requiring external technical assistance.

5.2 ID proceeded with the Yin project using government funds. The change in government leadership in 1988 ushered in a new era of prominence for ID. The present Minister of Agriculture is a vigorous supporter of the irrigation sector, and since 1992 has managed to vastly expand public funds allocated to new construction as well as to maintenance. At the time of the June 1995 OED mission, ID was implementing 29 new projects, most of them larger than the two dams discussed here. Construction time has fallen dramatically: ID claims works comparable to Kinmundaung now are taking two years rather than six. Almost all the schemes are concentrated in the dry zone, demonstrating the priority government puts on its policy of "greening" this under-privileged area. There are no international donor funds involved in this burst of activity, with the exception of some tied Overseas Economic Cooperation Fund credits for Japanese procurement and an older project partly financed by the Asian Development Bank which is almost complete.

5.3 Despite its access to public funds, the ID is keenly interested in restoring its relation with the Bank, should Bank-country relations permit. The mutual, professional admiration of Bank technical staff and ID officers, which was evident in the files as well as the interviews, is a remarkable resource that can be easily reactivated. This is a partnership that worked, and worked well for Tank I despite the disappointments.

5.4 *Operations and Maintenance.* The OED impact team gave priority to O&M issues, which are elaborated in the impact study report. The team visited Kinda as well as Kinmundaung, and a separate visit by the OED Task Manager was made later to Azin. ID's performance, with government's financial support, stands out in the regional study of O&M. The budget is not as large as it should be to address all needs, but there was no sign of the neglect in funding and attention evident to varying degrees in the other countries.

5.5 Nevertheless, the good performance is not uniform across the spectrum of O&M activity. ID's operational performance at the headworks and on the main canals and distributaries cannot be faulted. In the regional setting, ID's standards of maintenance of these works and controls is exceptional. The condition of the dams, canals and masonry structures for controls was uniformly good. Similarly, farmer maintenance of their distribution channels—the tertiary canals and farm-to-farm ditches—also seemed to be adequate to keep the water flowing to the fields. That was not the case in the lower half of the system at Kinmundaung and the tail end of the left
main canal at Kinda, where there have been no, or hardly any, deliveries. But this easily explains farmer disinterest in cleaning the channels. Elsewhere, where the water could reach, the farmers kept it moving.

5.6 One notable feature at the Myanmar sites is the way farmer labor is mobilized to help ID clean the main canals. This is uncompensated labor, and all farmers in the villages receiving irrigation, whether their farms actually get water or not, are expected to—and do—participate. This is an indication that ID's O&M requirements are not fully funded by government. Nevertheless, the tradition of obligatory farmer support for the cleaning operation (not repair) is so rooted in Burmese culture that the budget gap is easily closed by free labor.

5.7 The main gap in O&M, which is easily seen at Kinmundaung and Kinda, is the almost complete lack of control of water distribution below the main distributary turnoffs. The project gates are missing, and the substitute, farmer-made blocks of cloth, earth and banana stalks are put in place only when the farmer wants to keep canal water levels high enough to ensure full discharge above the block (at the cross-canal controls), or to keep water off their own fields (at the turnoffs). The controls are not used to do the main job they were intended for, which was to enforce a rotation that would deprive upstream farmers of continuous delivery. This shows up as a maintenance problem, in damaged, dysfunctional or missing gates. But it is fundamentally an operational problem, because of the lack of respect for planned rotations and improved water management. This "maintenance" problem is not evident at Azin, because there is an abundance of water, the gates are used to direct abundant water to all participants or to prevent over-flooding, and the gates are considered farmer-friendly. At the other two sites where water is less abundant, the gates are considered unfriendly by farmers behind them.

5.8 The SAR emphasized the importance of good water management and water conservation. This was thought to be particularly important at Kinmundaung, where only good management would allow a greater area of dry season crops. Even at Azin, where the scheme size was accurately dimensioned to the catchment capacity, any substantial slippage from good water management standards implied unnecessary tail-end stress in the dry season. As implementation progressed, the Bank's supervision reports reflect a growing preoccupation with MAS' failure to organize and instruct the future irrigators in improved methods of water management. By the end of the project, lack of farmer organization and inadequate training were among the central themes of the reports. The PCR refers not just to the weakness but to the absence of farmer user groups:

"Maximum possible utilization of rainfall and avoiding waste of reservoir water through over-irrigation is, therefore, important. Formation of farmers' groups to control distribution of water on the watercourse and its maintenance, and availability of extension advice for irrigated agriculture, will have to be actively pursued" (PCR, para. 7.01).

5.9 But the PCR fails to distinguish between the different O&M functions. In fact, OED found in Myanmar systems of effective association that are regionally outstanding. They were invariably targeted at problems that concerned all or at least most of the farmers. The farmers organized when they had to clear canals for everyone's benefit. They did not organize simply to discuss rotations. Head-enders had no interest in doing so. Tail-enders anticipated no productive results from trying to do so.
5.10 ID has been unwilling or unable to impose rotations at the tertiary and watercourse levels. But it has shown its potential for enforcing rotations by rationing water at turnoffs higher up the system, for example when it assigns the pre-monsoon water to specified blocks at Kinmundaung and when it rotates between groups of primary distributaries at Kinda. Kinmundaung is a special case even within the examples of water rationing. The shortage to date has been so large as to make redundant half of the canal infrastructure. An "equitable" solution is out of the question. User groups cannot handle that problem.

5.11 In short, O&M performance at the tanks is adequate to take advantage of available water without letting the essential assets disintegrate. The absence of farmer-organized rotations is compensated by effective ID intervention. Broken gates may have an equity impact but do not depress overall production.

5.12 Cropping Patterns. Another disappointing feature on the operational side of this project is the failure of the farmers to advance to more diversified and profitable cropping systems. The driving force behind this reform as it was projected at appraisal was the low international price of rice. The paddy crops by themselves could not provide the economic returns needed to offset the construction costs. The financial returns to paddy might be attractive to the farmers, the economic returns would not be attractive to Myanmar. As discussed above, other crops were introduced in the plans for both Kinmundaung and Azin to justify the investments. Cotton would rescue Kinmundaung; the orchards would rescue Azin.

5.13 The Kinmundaung farmers rejected cotton. OED was told that cotton prices have not been attractive enough to persuade farmers to switch from the familiar paddy to a crop which needs more cash inputs and care to prosper. Improved seed has become available recently, and, coupled with an improvement in relative prices, MAS officers at its Kinmundaung farm anticipate an increase in interest in cotton. But as of mid-1995, eight years after the first water releases were made from the dam, this premier crop which prompted such attention at appraisal has not been planted anywhere on the farmers fields. In a sense this a failure of the MAS agents, who may have been able to promote some shift in the cropping pattern if they had thrown their full weight behind it.

5.14 Yet actual cropping patterns reflect a mix of farmer preferences and public policy. The pre-monsoon paddy grown at Kinmundaung is primarily a product of public policy. Under ministry instruction, ID allocates the rationed water releases to demarcated blocks of farmers who are obliged to grow the specified crops. For example, the paddy grown on the Kinmundaung right main canal in 1994 and 1995, and the sesame grown on the left main canal in 1994, were prescribed. Farmers within each block had no options other than to be left out or lose their right to cultivate the plot, both unacceptable alternatives. Farmers told the OED mission that they would have preferred to grow sesame instead of paddy had the choice been theirs. The pre-monsoon water released by ID in the years up to 1992 had been allocated to sesame. The switch to paddy in 1992 was prompted by government's grow-more-paddy campaign, which began that year. This policy matrix must be kept in mind when analyzing cropping patterns, and evaluating the effectiveness of incentives for shifting to improved and more profitable mixes of crops.

5.15 One implication is that government could have but did not try to intervene at Kinmundaung to target part of the water released by ID to blocks specified for cotton, in support of the appraisal design. This is not a test of government "ownership" of project design. The
planning and procurement quotas are not so unenlightened or heavy-handed as to force farmers into cropping rotations expected to be risky, unpopular, and likely to fail.

5.16 At Azin the prospects for substitution are narrower. MAS researchers at the station near Mudon have tested other crops. But they feel the heavy soils within the project perimeter are such that only ten percent of the command area could be shifted to a mixed double crop regime. The fact that a second paddy crop has done so well is itself a success story for MAS, since it was not until MAS introduced HYV short season rice varieties for the monsoon period that it could guarantee farmers that they could harvest the monsoon crop in time to plant the summer crop of paddy. In any case MAS' strategy now is to introduce a third, non-paddy crop in the rotation, in the pre-monsoon period (note that at Azin a pre-monsoon crop is an innovation, unlike at Kinmundaung). As mentioned elsewhere in this report, whether the farmers will accept this additional shock to the rhythm of their lives is as yet untested.
MYANMAR

TANK IRRIGATION PROJECT
AZIN SUBPROJECT

- DAH AND RESERVOIR
- IRRIGABLE AREA - UPLAND (ORCHARDS)
- IRRIGABLE AREAS - LOWLAND (PADDY)
- MAIN CANAL
- DISTRIBUTARY CANALS
- TERTIARY CANALS
- DRAINS
- ROADS
- PROJECT ROAD
- RAILWAYS
- RIVERS
- VILLAGES

IRRIGABLE AREAS
- UPLAND (ORCHARDS)
- LOWLAND (PADDY)

MAIN CANALS
- DISTRIBUTARY CANALS
- TERTIARY CANALS
- DRAINS
- ROADS
- PROJECT ROAD
- RAILWAYS
- RIVERS
- VILLAGES

IRRIGABLE AREAS
- UPLAND (ORCHARDS)
- LOWLAND (PADDY)

KILOMETRES

MILES

0 1 2 3

0 1 2