Rice Irrigation in Malaysia

Economic Change and the Choice of Irrigation Technology

The Bank has supported irrigation development for rice cultivation in Malaysia since the mid-1960s. An OED audit of three projects in Western Peninsular Malaysia, implemented in 1978-90, addresses some sectoral issues in public irrigation for rice cultivation in Malaysia.*

Performance of these projects, like that of Malaysia’s rice sector generally, was deeply affected by the dramatic structural changes that occurred in the economy during the implementation period. Rapid escalation in the costs of labor, land, and construction pushed the sector toward mechanized farming, changing its needs for irrigation water. As a result, the projects now appear to be economically less viable than at appraisal. Technically, the projects performed below expectations.

In Malaysia’s increasingly industrialized economy, rice production seems likely to become marginal, compared to other activities. But for the Bank, the experience in these projects yields lessons for the engineering design of future irrigation projects in the tropics.

Malaysia has a long tradition of support for irrigated rice development, both to retain a degree of self-sufficiency in rice production and to help alleviate poverty among smallholder rice farmers. The support includes substantial subsidies for fertilizer and credit, a guaranteed minimum price, and a price bonus, as well as considerable investment in public irrigation works. Yet Malaysia is a relatively small rice producer. Paddy supplies only one percent of GDP and five percent of agricultural value-added.

The Fifth Plan (1986-90) reduced the rice self-sufficiency goal from 80-85 percent of consumption to 60-65 percent of consumption by year 2000, and concentrated public investments in eight "granary" areas covering 220,000 ha. The continuing national decline in rice production shows that even with high subsidies ($220 per ton in 1988), the reduced self-sufficiency targets are not being achieved. Gross paddy production fell from 2.1 million tons in 1979 to 1.6 million tons in 1987, and has fallen further since. Rice consumption fell from 1.34 million tons in 1979 to 1.23 million tons in 1987.

Project goals, design

Bank loans totaled US$83.5 million for the three projects: Northwest Selangor Integrated Agricultural Development (NWSP); Krian-Sungei Manik Integrated Agricultural Development (KSMP); and Muda II Irrigation. KSMP consisted of two separate schemes, the larger—Krian—covering about four times the command area of the other—Sungei Manik. All the projects are within the “granary” areas (designated by government in 1984), where rice is essentially the only crop grown.

All three projects added to existing rice irrigation systems, in order to improve the productivity and incomes of smallholder

* "Performance Audit Report, Malaysia: Northwest Selangor Integrated Agricultural Development Project; Krian-Sungei Manik Integrated Agricultural Development Project; Muda II Irrigation project; Rompin-Endau Area Development Project." Report No. 97:14, June 28, 1991. OED reports are available from the Internal Documents Unit and from Regional Information Centers.
Rice Yields "With and Without Project"

Paddy yields in most irrigated areas of Malaysia have traditionally been quite high. Yields in the three project areas surpass those in many other parts of Asia, but not enough information is available to assess how much these yields, or the increases that have taken place in cropping intensity, owe to the investments supported by the projects.

Data from Muda do provide a with/without project comparison. They show no significant difference in paddy yields between tertiary blocks that benefited from Muda II—"Muda II blocks"—and those that did not. Muda II blocks made up a fourth of the command area, scattered through it randomly; non-Muda II blocks made up the rest; both are served by the same secondary canal. Paddy yields were only 0.7 percent higher (2.3 kg/ha) on Muda II blocks than on non-Muda II blocks for the years 1981-86. Cropping intensity in Muda II was only 1 percent higher, at 199 percent. On Muda II blocks than on the other blocks, at 191 percent. Both with and without Muda II, cropping intensity was noticeably higher than the appraisal "without-project" estimate of 175 percent.

In the world economy, belied these assumptions. Per capita income rose rapidly in the 1980s, except in the 1985-86 recession. Industrialization and growth were accompanied by sharply increased wages, decreased farm labor supply, higher costs of construction and land, and inflation. Agriculture’s share of GDP diminished and, within agriculture, cash crops such as oil palm and rubber became more profitable than rice.

International rice prices fell in 1982 and since then have been much lower than in the late 1970s. Many farmers left paddy farming for other occupations, usually retaining ownership of their land and renting it out to others. Given the subsidy level, paddy production has remained profitable for entrepreneurial farmers, who have mechanized their operations and grouped small farms together into units large enough to take advantage of economies of scale.

Mechanization: Faced with higher wages and sharply reduced labor supply, farmers have mechanized land preparation, seeding, and harvesting to reduce production costs, labor inputs, and production time. Mechanization, which started in a small way in the 1950s, spread rapidly during the 1980s. (While mechanization saves labor, it does not itself increase paddy yields per hectare.) Mechanization is almost complete in the Northwest Selangor, Muda II, and Sungei Manik project areas and is spreading in Krian.

Larger-scale farming: Possibilities for mechanization have encouraged owners or managers of small farms to group them together in larger operating units (up to about 100 ha), which allow economies of scale in mechanized ploughing, seeding, and harvesting, and more efficient use of water. In Muda, such units have been formed on private initiative. In Northwest Selangor, “mini-estates”, often run by a project manager for their owners, have been promoted by the government; they cover about a fourth of the cropped area and can be very efficient.

Project results

In general, quantifiable benefits from these projects have been well below SAR targets. Paddy yields and cropping intensities in the project areas increased somewhat, but not by nearly enough to justify the projects on economic grounds (and, possibly, not by much more than in nonproject areas—see Box). Increases in cropping intensity were made possible mainly by the water savings associated with the switch to direct, or “dry”, seeding and by farmers’ own pumping of water from canals and drains. (Over the crop cycle, directly seeded rice typically requires less water than does transplanted rice, but more control over the amounts and timing of water.)

Higher wages, shortages of farm labor, and escalating construction costs and land values substantially raised project costs and delayed implementation (see table). In Northwest Selangor, Krian, and Sungei Manik, the glass-reinforced polyester (GRP)
Project Costs and Outcomes

<table>
<thead>
<tr>
<th>Loan Amount (US$M)</th>
<th>Implementation (Yrs.)</th>
<th>ERR (%)</th>
<th>Cost (US$)</th>
<th>Application</th>
<th>Actual</th>
<th>Planned</th>
<th>Actual</th>
<th>Appraisal</th>
<th>Completion</th>
<th>Audit</th>
</tr>
</thead>
<tbody>
<tr>
<td>NWSP</td>
<td>60.0</td>
<td>87.0</td>
<td>26.0</td>
<td>5.0</td>
<td>7.9</td>
<td>19</td>
<td>1</td>
<td>0</td>
<td>5.4</td>
<td>Neg.</td>
</tr>
<tr>
<td>KSMP</td>
<td>60.2</td>
<td>128.0</td>
<td>26.5</td>
<td>5.1</td>
<td>9.1</td>
<td>20</td>
<td>5.4</td>
<td>Neg.</td>
<td>18</td>
<td>5.4</td>
</tr>
<tr>
<td>Muda II</td>
<td>69.0</td>
<td>94.6</td>
<td>31.0</td>
<td>4.5</td>
<td>11.5</td>
<td>18</td>
<td>5</td>
<td>5</td>
<td>5</td>
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</tr>
</tbody>
</table>

flumes for tertiary canals—a major technical feature of the project designs—failed because of their weak structures, rapid deterioration due to exposure to the elements, and susceptibility to damage by farmers. Their replacement with much more expensive concrete conduits substantially added to costs and to implementation times.

Economic rates of return (ERRs) at project completion and at the time of audit were much lower than the appraisal estimates (see table). In retrospect, it is difficult to justify the investments in these three projects on economic grounds. This would still be the case even if the rice price forecasts made at appraisal had proved correct.

Non-quantifiable benefits from the projects were numerous, however. Agricultural services were provided. The wider access roads constructed made remote farm areas accessible to combines—promoting mechanization—and also made it possible to provide electricity and water supply for households in those areas.

Operational performance

The operational performance of the irrigation works has been below expectations. Technically, the NWSP and Krian facilities are not operating according to plan. Muda II and the Muda irrigation system as a whole work more nearly according to plan, though it appears that the tertiary facilities built under Muda II have not made much difference in rice output.

The technical changes in rice farming—particularly the move to direct seeding—associated with mechanization have had marked effects on demand for irrigation water. They make it much more important for farmers to be able to control the amounts and timing of water deliveries. And in practice they also mean that planting and harvesting dates are less uniform than they used to be, so that neighboring farmers no longer demand water at the same time as one another. Project engineers recognize that it is technically impractical to meet the increasingly individualized water demands of mechanized farms through gravity-based, surface-flow systems like those supported in these projects. Because the project schemes cannot fine-tune and micro-plan water deliveries, the canals in general deliver more water per hectare than necessary.

To achieve the control they need over amounts and timing of water, farmers in Muda and parts of Northwest Selangor buy and install their own low-lift pumps to lift water from public canals and drains. Although this costs them more than the public irrigation water, pumping is preferable to the prospect of reduced yields or a lost crop due to insufficient or untimely water supply.

NWSP: The main operational problem is uneven water distribution and the droughts that occur every 4 or 5 years. The uneven water distribution causes difficulties for mechanized farming, which requires more controlled supplies of water than unmechanized. The irrigation system was designed for transplanted paddy, rather than direct seeding.

Krian: Krian was designed assuming that 30 percent of the rice crops’ water needs would be met directly by rain, but is operated as if there were little rainfall; hardly any effective rainfall is considered in planning water deliveries. Though annual rainfall in the command area is substantial (2,500mm/year), it is somewhat variable. The irrigation authority draws more water than planned from the Bukit Merah reservoir and by pumping from a diversion canal off the Krian river. The low coastal areas of Krian Laut are constantly flooded because of the high water levels in secondary and tertiary drains. As a result, mechanized farming is greatly restricted, and an undesirable staggered cropping pattern has evolved. Significant agricultural benefits will only be realized once water is fully removed from the constantly flooded fields and a hardpan is formed.

Muda II: The scheme as a whole relies more heavily on pumping than was planned; the irrigation authority has installed eight low-head high-discharge pumps that draw water from drains to augment water in the
main canals; the original project design planned for pumped water supply only for areas that were outside the gravity command area. The public operating costs of the scheme per hectare irrigated are far higher than envisaged.

At present, field engineers need latitude to make small, timely modifications to the irrigation systems to resolve problems that arise. These responses can often produce more effective and less costly solutions than more comprehensive approaches that produce small improvements at great cost.

Implications

Prospects for higher international rice prices are poor, and the opportunity cost of Malaysia’s rice subsidies is large. The evaluation of these projects reinforces current efforts by the Government and the Bank to review the pros and cons of its rice subsidy policy, possibly leading to a greater reduction in subsidy than is currently planned.

Changes in paddy cultivation over the last decade have implications for the design and operation of future public investments to support the sector:

- In low-lying areas of Krian Laut, with their excessively high water levels, proper drainage and greater integration between crop seasons is essential for the drying up process and formation of hard-pan that will encourage mechanization. Construction of field bunds and dams should be encouraged.
- Experience with the GRP flumes used for the tertiary canals emphasizes the need for realistic pilot testing of technologies. Even if a technology is cheap, unforeseen problems in its large-scale application can be very costly.
- As mechanization has broadened and deepened, and as wages have risen and time is more valued, investments to support agriculture increasingly need to concentrate on follow-on activities such as better farm roads and agricultural services.
- As farm operating units have grown larger, construction of tertiary canals and drains has become less important, since these units typically stretch all the way from secondary canals to drains. Field engineers need latitude to make small timely modifications in response to nascent problems.
- Encouragement of private pumping from canals and drains, although not a universal solution, may be a viable way to overcome the technical limitations of the existing gravity-based, surface-flow irrigation systems. Private pumping appears to be financially and economically attractive to everyone. And, because it makes current irrigation systems more flexible, it would help them adapt to the anticipated diversification away from dry-season paddy.