



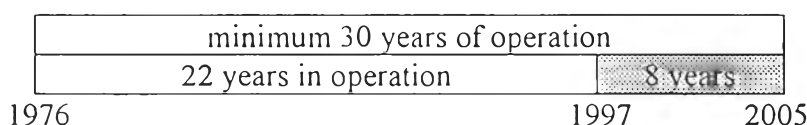
Chapter 4

Average Incremental Cost

4.1 Future Project Duration

According to the Operation and Maintenance Division of the RID central office, Nong Wai Irrigation System does not have a determined project lifetime. In other words, the system is assumed to be in operation for unlimited years with necessary improvement and maintenance. On the other hand, the study report on cost recovery of the Nong Wai Pioneer Agriculture Project, which was conducted as part of the Nong Wai Irrigation Project Feasibility Study by Sanyu Consultants Inc. in 1976, sets 30 years as the longest optional period of cost recovery for the construction of Nong Wai Irrigation System^{*}. This can be interpreted that Nong Wai Irrigation was planned to operate for the minimum of 30 years. The 1997 Annual Report of Nong Wai Irrigation Project, which is the most recent annual report of the project available, contains a record of water delivery for the past 22 years (1976-1997). In 1997 therefore the Nong Wai Irrigation Project was expected to reach the minimum operation period of 30 years after another 8 years (refer to Chart 4-1). This study therefore adopts 8 years as the minimum future project duration, for the calculation of Average Incremental Cost (AIC) of Nong Wai Irrigation water. This study employs two discount rates, 12 % and 10 %. 12 % is the rate that RID normally uses in its regular analysis. 10 % is closer to 10.5 % which is the rate often used in projects reflecting lower discount rates after the recent economic and financial crisis in the country.

Chart 4-1 Future Project Duration (t)



^{*} The report presents eight scenarios of the construction cost recovery period: 10 year repayment period with 2 or 5 year grace period; 15 year repayment period with 2 or 5 year grace period; and 25 year repayment period with 2 or 5 year grace period. The longest recovery period suggested is 30 years (25 years for repayment plus 5 year grace period).

4.2 Incremental Investment Cost

The incremental investment cost in the case of Nong Wai Irrigation is the investment for improving the irrigation system. RID Nong Wai Project Office drafts a five year workplan for irrigation system improvement, and submits it to the regional office and the central office of RID for budget approval. According to the workplan for 1998-2002 (refer to Table A-1), the budget of system improvement includes the following components:

1. Improvement of canals
2. Improvement of water control facility
3. Improvement of drainage system
4. Construction of ditches
5. Improvement of ditches
6. Installation of drainage capstan
7. Installation of electricity gear and motor
8. Installation of electricity system
9. Construction of workhouse and others
10. Roads and signs
11. Constriction of accommodation

For the purpose of calculating AIC for irrigation water, the study proposes two options of incremental costs regarding system improvement. One option includes the costs of system improvement directly related to water delivery at all levels of the irrigation system. The other option includes the cost of system improvement directly related to water delivery only at the farm level.

The first option covers the following 8 items out of the 11 items listed in the workplan.

1. Improvement of canals
2. Improvement of water control facility
3. Improvement of drainage system
4. Construction of ditches
5. Improvement of ditches
6. Instalment of drainage capstan
7. Instalment of electricity gear and motor
8. Instalment of electricity system

The annual budget for the year 2003, 2004 and 2005 was estimated for each of the 8 selected items based on the budget allocation within the period of 1998-2002 in the five year plan. As shown in the Table A-2, only construction of ditches and improvement of ditches are likely to continue after 2002. The other 6 items have negative estimate figures for years beyond 2002 based on the declining budget

allocation towards the end of the five year plan, indicating that those 6 items of system improvement are likely to finish by 2002.

The second option of the incremental investment cost includes only 2 items of the farm level system improvement cost, namely construction of ditches and improvement of ditches. Based on the five year work plan and projection for additional three years after the five year period, those 2 items both are expected to receive more or less the same level of the annual budget throughout the period between 1998 and 2005 (refer to Table A-3).

Environmental cost

RID Nong Wai Project Office conducts periodical surveys of irrigation water every 3-4 months. The survey covers water salinity, water pollution and ground water level. The 1997 Annual Report of Nong Wai Irrigation Project shows the water in the project area to be in good condition. A official at the RID regional office in Khon Kaen province assured that Nong Wai Irrigation area has not experienced water salinity, which is rather common in the Northeast region. Nong Wai Irrigation Project does not allocate a specific budget to cover the environmental cost, but the improvement of drainage system mentioned in the system improvement cost can be interpreted as an investment in wastewater treatment as part of the effort for environmental improvement.

4.3 Incremental Operation and Maintenance Cost

RID is responsible for the operation and maintenance of the primary and secondary level of irrigation canals and other facilities of Nong Wai Irrigation. The annual operation and maintenance cost of Nong Wai Irrigation Project born by RID is comprised of the following components:

- Management cost (including salary of RID project office staff)
- Maintenance cost
- Rehabilitation cost
- Others
- Cost of maintenance and improvement of the project

RID does not make a long term workplan for operation and maintenance of Nong Wai Irrigation. Instead the RID project office requests budget for operation and management annually. The record of the operation and maintenance cost for the past ten years shows that the annual cost of the operation and maintenance of Nong Wai Irrigation was higher in some years and lower in other years (refer to Table A-4). The general trend of the operation and maintenance cost does not seem to correspond to the increase/decrease in irrigation water delivery. It is quite uncertain how the operation and maintenance cost will change in the future years, and it may not increase in proportion to the growth in water delivery. This study, therefore, will not consider

incremental operation and maintenance cost as one of the cost components used for the calculation of AIC of Nong Wai irrigation water.

Operation and maintenance of the farm level irrigation ditches is taken care of by farmers who benefit from Nong Wai Irrigation. According to the project feasibility study and other project related documents, farmers in the target area of Nong Wai Irrigation are divided into water users groups that would collect water charges from farmers. The collected fees are to be sent to Nong Wai Agricultural Cooperative which oversees operation and maintenance of Nong Wai Irrigation at the farm level.

According to the finance section of Nong Wai Agricultural Cooperative, however, it was very difficult to collect water fees from farmers, and the cooperative has practically stopped water fee collection since ten years ago. Ten years ago, the cooperative collected 30 baht per rai of paddy field as water charge from farmers. After water charge was stopped, farmers maintained irrigation ditches in their areas individually. That is, the cost of operation and maintenance of Nong Wai Irrigation at the farm level is born by farmers benefiting from irrigation water themselves. This study, therefore, will not count the operation and maintenance cost at the farm level into calculation of AIC of Nong Wai irrigation water.

4.4 Incremental Volume of Water

The 1997 Annual Report of Nong Wai Irrigation Project provides the record of annual water delivery from Nong Wai Irrigation Headwork Compound from 1979 to 1997 (Table A-5). The record separates the amount of water delivery for rainy season and for dry season. The record for both rainy season and dry season for the past 22 years shows the overall trend of increase in water delivery. Based on the past record, the annual water delivery of Nong Wai Irrigation for the future years was estimated for rainy season and dry season (Table A-6). The difference between the estimated figure for a future year and the recorded figure for 1997 is the incremental amount of irrigation water used in the AIC calculation (Table A-7).

4.5 Opportunity Cost of Water

In rainy season, water from Nong Wai Irrigation provided for agriculture is solely used for paddy cropping. In contrast, in dry season a small portion of irrigation water is used for growing other grains and vegetables besides paddy. The forgone benefit of the incremental amount of dry season irrigation water when it was used for growing other crops than paddy can be viewed as the opportunity cost of incremental amount of water. This value is included as a cost component to AIC calculation for dry season.

In order to calculate the opportunity cost of incremental amount of irrigation water in dry season, this study has chosen soybean as an alternative crop to paddy. Soybean is one of popular cash crops grown in the project area. In theory, the opportunity cost should be calculated based on the market price of soybean and the market price of production inputs used to grow soybean. In this particular case of soybean production in Thailand, both the farmers' selling price of soybean, and production inputs such as fertiliser and pesticides, are likely to be subsidised by the government in various forms. It is then very difficult to estimate the real net benefit of growing soybean. Moreover, the real net benefit could be possibly a negative figure given falling prices of agricultural products and, on the other hand, increasing prices of agricultural inputs.

As an alternative to the real net benefit, this study uses farmers' receiving benefit of growing soybean as the opportunity cost of water. While the receiving benefit figure is distorted by subsidies, it is the actual concern of farmers in deciding what crop to grow. The opportunity cost of water, or the net benefit of one cubic meter of water used in soybean production is calculated as follows.

$$\frac{\text{average yield (kg/rai)} \times [\text{farmers' selling price (baht/kg)} - \text{production cost (baht/kg)}]}{\text{irrigation water requirement (m}^3\text{/rai)}}$$

Average yield:

According to the table below, the average yield of soybean in Khon Kaen Province in dry season (second crop) is 216 kg/rai.

Table 4-1 Production of soybean in Khon Kaen Province and Northeastern Region of Thailand

Soybean	Planted Area (1,000 rai)		Production (1,000 ton)			Average Yield (kg/rai)			
	First Crop	Second Crop	First Crop	Second Crop	Total	Total	First Crop	Second Crop	Total
Khon Kaen Province	14,808	58,863	218	216	216	73,671	3,228	12,714	15,942
Northeast Region	67,517	233,405	196	215	211	300,922	13,221	50,170	63,391

Source: Bank of Thailand Khon Kaen Branch, 1999

Farmers' selling rice:

Nong Wai Agriculture Cooperative has a business of buying farm products from cooperative members and selling them to the market. Soybean is one of the crops the cooperative buys. The 1997 Annual Report of Nong Wai Agricultural Cooperative reports the purchase of rice and soybean from cooperative members as shown in the table below. It shows that the cooperative bought 81,933 kg of soybean for 948,618 baht, that is, the farmers' selling price was around 8.63 baht/kg on average. The study adopts 8.63 baht/kg as the farmers' selling price for soybean.

Table 4-2 Farmers' selling price of rice and soybean

	Amount (kg)	Sum (baht)
Unpolished rice	1,013,140	4,461,736
Soybean	51,702	446,236
Business development project rice	269,233	1,595,400

Source: 1997 Annual Report of Nong Wai Agricultural Cooperative

Production cost:

The table below shows that the average production cost of soybean is 7.12 baht per kg of soybean produced.

Table 4-3 Production cost for soybean

	Variable Cost (baht/rai)	Fixed Cost (baht/rai)	Total Cost (baht/rai)	Average Cost (baht/kg)
Soybean	1,350.13	159.32	1,509.45	7.12

Source: Office of Agricultural Economics, Ministry of Agriculture and Cooperatives, 1999

Irrigation water requirement:

RID calculates crop water yield for individual crops for each province. According to the crop water yield table for Khon Kaen Province (Table A-8), soybean requires 690.06 m³ of water per rai throughout its crop life of 100 days. Effective rainfall is minimal during dry season, so for the sake of convenience rainfall will not be considered. Irrigation efficiency is estimated to be 60-75 % during dry season. In other words, 25-40 % of irrigation water is lost before reaching crops in the field. If using 60 % as irrigation efficiency, irrigation water requirement for soybean cropping per rai during dry season is calculated to be 690.06 m³ / 0.6, or 1150.1 m³. This figure will be used as irrigation water requirement for soybean. Applying the above figure for each component of the formula, the opportunity cost of one cubic meter of irrigation water can be derived as follows.

average yield (kg/rai) x [farmers' selling price (baht/kg) – production cost (baht/kg)] / irrigation water requirement (m³/rai) = [216 kg/rai x 1.51 baht/kg] / 1150.1 m³/rai = 0.28 baht/ m³.

The table below compares the net benefit and the opportunity cost of water for second rice (dry season) and soybean. It shows that second rice brings net income for farmers nearly three times higher than soybean, which is likely to be the main reason for farmers to grow rice rather than soybean in dry season. This high net benefit makes the opportunity cost of water for rice higher than that for soybean, despite twice higher water requirement for rice compared to soybean.

Table 4-4 Opportunity cost of water for soybean and second rice

	Variable Cost (baht/rai)	Fixed Cost (baht/rai)	Total Cost (baht/rai)	Average Cost (baht/kg)	Farm Price (baht/kg)	Net Benefit (Baht/kg)	Yield (kg/rai)	Net Benefit (baht/rai)
Soybean	1350.13	159.32	1509.45	7.12	8.63	1.51	216	326.16
Second Rice	1421.03	190.13	1611.16	3.406	4.637	1.231	610	750.91

	Net Benefit (baht/rai)	Water Requirement (m3/rai)	Opportunity Cost of Water (baht/m3)
Soybean	326.16	1022.31	0.319042169
Second Rice	750.91	2500*	0.300364

Information on variable, fixed, total and average cost adopted from data provided by The Office of Agricultural Economics, Ministry of Agriculture and Cooperatives*

* Figure used by RID Nong Wai Project Office

Source: Office of Agricultural Economics, Ministry of Agriculture and Cooperatives, 1999

* Data were taken from the homepage of the Office of Agricultural Economics, [http:// oae.hpcc.nectec.or.th](http://oae.hpcc.nectec.or.th)

Average Incremental Cost of Irrigation Water

Using the information mentioned above, AIC of Nong Wai Irrigation water was calculated at two different levels: one with the system improvement cost only, and the other with the system improvement cost and the opportunity cost of water. AIC of irrigation water with the system improvement cost only is applicable to both rainy season and dry season. On the other hand, AIC with the opportunity cost of water in addition to the system improvement cost is applicable only to dry season when farmers grow other crops than rice using irrigation.

Table 4-5 AIC of Nong Wai Irrigation water

Option 1: Full system improvement cost

Interest rate	$\sum_{t=1}^r (I_t + R_t - R_0) / (1+r)^t$	$\sum_{t=1}^r (Q_t - Q_0) / (1+r)^t$	AIC
Without opportunity cost of water			
10 %	5138213.346	3456795.895	1.486
12 %	4283990.804	2841811.961	1.507
With opportunity cost of water			
10 %	6119943.382	3456795.895	1.770
12 %	5091065.401	2841811.961	1.791

Option 2: Farm level system improvement cost

Interest rate	$\sum_{t=1}^r (I_t + R_t - R_0) / (1+r)^t$	$\sum_{t=1}^r (Q_t - Q_0) / (1+r)^t$	AIC
Without opportunity cost of water			
10 %	812981.2585	3456795.895	0.235
12 %	677718.7085	2841811.961	0.238
With opportunity cost of water			
10 %	1794711.294	3456795.895	0.519
12 %	1484793.306	2841811.961	0.522

Source: calculation of Average Incremental Cost

The official irrigation water requirement of paddy used by the RID Nong Wai Project Office is 1,600 m³/rai for rainy season and 2,500 m³/rai for dry season. Using these official figures, the estimate cost of water for each option of AIC for rainy/dry season can be derived as follows.

Table 4-6 Estimate cost of irrigation water

Interest Rate	Improvement Cost	Opportunity Cost	AIC (baht/m ³)	Rainy Season Cost of Water (baht/rai)	Dry Season Cost of Water (baht/rai)
10%	full cost	without	1.486	2377.6	3715
12%	full cost	without	1.507	2411.2	3767.5
10%	full cost	with	1.77		4425
12%	full cost	With	1.791		4477.5
10%	farm level	Without	0.235	376	587.5
12%	farm level	Without	0.238	380.8	595
10%	farm level	with	0.519		1297.5
12%	farm level	with	0.522		1305

Source: calculation of Average Incremental Cost

For rainy season, the estimate cost of water ranges from 376 to 2411.2 baht per rai of paddy field. For dry season, on the other hand, the estimate cost is 587.5 baht at the lowest and 4477.5 baht at the highest. If these AIC figures are compared to the net benefit from growing paddy, 189.336 baht/rai for major rice (rainy season) and 750.91 baht/rai (dry season) as shown in the table below, the estimate cost of water in most cases exceeds the net benefit. In other words, it is not realistic for farmers to bear 100% of the estimate cost of water, because their income from growing rice is lower than the full cost of water.

Table 4-7 Net benefit from soybean and rice production

	Variable Cost (baht/rai)	Fixed Cost (baht/rai)	Total Cost (baht/rai)	Average Cost (baht/kg)
Soybean	1350.13	159.32	1509.45	7.12
Second Rice	1421.03	190.13	1611.16	3.406
Major Rice	1067.79	189.96	1257.75	4.99

	Average Cost (baht/kg)	Farm Price (baht/kg)	Net Benefit (Baht/kg)	Yield (kg/rai)	Net Benefit (baht/rai)
Soybean	7.12	8.63	1.51	216	326.16
Second Rice	3.406	4.637	1.231	610	750.91
Major Rice	4.99	5.634	0.644	294	189.336

Information on variable, fixed, total and average cost adopted from data provided by The Office of Agricultural Economics, Ministry of Agriculture and Cooperatives*

Source: Office of Agricultural Economics, Ministry of Agriculture and Cooperatives, 1999

* Data were taken from the homepage of the Office of Agricultural Economics, <http://oae.hpcc.nectec.or.th>

There are two exceptional cases where AIC is actually lower than the net benefit of growing rice: the option with the farm level system improvement cost and no opportunity cost of water when applied to dry season paddy production with the interest rate of 10 and 12 %. AIC figures are 587.5 baht/rai with 10 % interest rate, and 595 baht/rai with 12 % interest rate, which are lower than 750.91 bath/rai, the net benefit from second rice production in dry season. Even in these cases, the estimate cost of water would take the major portion, nearly 80 %, of the net benefit of rice production. One conclusion derived from this AIC calculation is that the full cost of irrigation water is too high to be born by farmers given relatively low productivity of paddy cropping.