ECONOMIC ANALYSIS

A. Introduction

1. This assessment summarizes the results of an economic analysis undertaken for the combined ongoing project and additional financing for the Irrigation Management Improvement Project. The additional financing will finance cost overruns experienced under the ongoing project that are attributable to (i) the higher price awarded than the project preparatory technical assistance cost estimate for four civil works packages in the project; (ii) the increase in quantities for two of the four civil works packages; and (iii) the devaluation of the special drawing right against the dollar. There is no change of scope for the project. The economic analysis follows Asian Development Bank (ADB) Guidelines for the Economic Analysis of Projects.[1]

2. The economic analysis of the Irrigation Management Improvement Project considers both the original project and the additional financing as a single investment because the additional financing is to cover cost overruns on the original project, with no additional, separable assets added from the additional financing and no additional revenues attributable to the additional financing. The analysis is based on estimates of incremental benefits that will accrue from investment in infrastructure; improved management, operation, and maintenance; and agriculture support services covering 18,000 hectares (ha) of the Muhuri Irrigation Project. There is expected to be both an increase in crop yields resulting from improved irrigation delivery, and higher input use resulting from increased farmer confidence in access to irrigation and, in the longer term, reduced diversification of cropping patterns towards more market-oriented higher value crops, such as vegetables, leading to increased farm incomes and economic benefits.

3. Improved drainage implemented under the project will also benefit around 11,000 ha of low-lying land in addition to the 18,000 ha to be rehabilitated. These potential benefits have not been included in the economic analysis. There is also expected to be an increase in agribusiness activity to meet the increase in demand for farm inputs and product marketing and processing. On- and off-farm employment opportunities and economic activity generally are expected to increase within the Muhuri Irrigation Project and neighboring areas. Given the uncertainty of and difficulty in accurately assessing such indirect benefits, only incremental benefits resulting from crop production have been included in the economic analysis.

4. The Muhuri Irrigation Project will also generate a range of nonquantifiable benefits, including (i) an improved irrigation project planning system; (ii) the establishment of a private irrigation management operator (IMO) to undertake sustainable operation and maintenance (O&M) of secondary (level 2) and tertiary (level 3) irrigation facilities and serve as local agriculture development facilitator for input supply, technical support, and collective marketing; (iii) improved irrigation and related service delivery mechanisms with transparent and accountable governance; and (iv) strengthened farmers' representation in respect of water users' rights and responsibilities. There may, in addition, be a reduction in the risks to health of arsenic contamination of water extracted from tube wells, as irrigation will replenish the aquifer and reduce the level of arsenic.

B. Economic Rationale

5. The primary rationale for government involvement is because project interventions are public goods managed or facilitated by the government. The private sector in Bangladesh has shown little appetite to make investments into large irrigation schemes, and this further justifies

[1] ADB. 1997. *Guidelines for the Economic Analysis of Projects.* Manila.

the government's involvement in the project. Revenue generation from project interventions will be limited to project beneficiary farmers paying for part of the ongoing O&M costs to a private IMO that will be contracted to operate project assets. This will be the first time in Bangladesh that a private IMO will operate publicly owned irrigation assets. It is a small step towards greater private sector involvement—possibly including farmers who use irrigation water—in developing and operating irrigation assets.

C. Demand Analysis

6. The primary sources of irrigation water in Bangladesh are local rainfall and transboundary inflows, derived mainly from the Brahmaputra, Ganges, and Meghna rivers. Bangladesh occupies only 8% of the total drainage area of these rivers but is located at their downstream end. The result is an abundant excess of surface water during the summer monsoon months and water shortfalls during the winter dry months. Despite being scarce, water is not well-managed. Minimal attention is given to water use efficiency and equitable allocation. Many farmers rely on groundwater to supplement the limited and irregular surface water supplies. However, in many areas, the use of groundwater is significantly constrained by arsenic contamination and aquifer limitations. Consequently, farmer demand for irrigation water is high.

7. The project also supports the government to address the recurrent lack of sustainable management and O&M and increase water productivity by transferring these functions to private operators and introducing innovative infrastructure modernization. Farmer demand for irrigation water provided by private sector operators (which may include farmers who draw water from an irrigation scheme) is not yet clear, but demand for the project is expected to be high because farmers have a financial incentive to join the project. If farmers join the project, they will be able to increase their margins, even though they will pay a tariff to join the project.

D. Project Alternatives

8. Project interventions for the original project were carefully prepared for cost effectiveness, and O&M capacity, after comparing them with alternative solutions. The project interventions represent the most cost-effective approach to achieving the project's outputs and outcome.

9. Methods and costs were derived after a review of similar work done in similar projects in Bangladesh and elsewhere. A team of experts in irrigation and farming systems analyzed alternatives for the design of the irrigation system—earth channel irrigation versus piped irrigation—and the energy sources for irrigation (diesel versus electricity; from the grid versus photovoltaic solar electricity) before deciding on the technical approaches used in the project. This resulted in the phasing out of the diesel- and/or electric-powered earth channel irrigation and its replacement by an improved electric pump and piped system.

E. Benefit–Cost Analysis

1. Introduction

10. The economic analysis compares incremental costs and benefits resulting from investment in the modernization of the Muhuri Irrigation Project. Crop and farm budgets were prepared for the original project to estimate with- and without-project crop gross margins per hectare and with- and without-project net farm incomes. Crop budgets were estimated from data on physical inputs and outputs, prices, and related variables derived from field investigations. Farm budgets were prepared by applying crop budgets to cropping patterns and crop areas to

two representative farm sizes—0.2 ha and 1.0 ha. The financial crop budgets were converted to economic values to determine with- and without-project economic crop gross margins per hectare, which have been applied to project-wide, with- and without-project cropping patterns to derive with- and without-project total gross margins.

11. Project-wide cropping patterns have been based on the cropping patterns of the individual farm budgets, weighted according to the estimated distribution of each representative farm within the project area, which is 90% for the 0.2 ha farms and 10% for the 1.0 ha farms. Net incremental benefits have been derived by subtracting total without-project gross margins from total with-project gross margins. Net incremental benefits and incremental investment and O&M costs of the project in economic terms have been combined to derive a cash flow from which the economic internal rate of return (EIRR) is estimated. The cash flow also includes an allocation of overhead project costs, such as consulting services, program management, and capacity building; 20% of these costs have been included in the investment cost of the project.

2. Cost Estimates

12. The Muhuri Irrigation Project cost estimates are based on the expected incremental costs of investment in project modernization and expansion, periodic maintenance, and annual O&M, including the costs of establishing and operating the proposed IMO. O&M of key level 1 infrastructure will remain the responsibility of the Bangladesh Water Development Board. O&M of the level 2 and level 3 infrastructure will be the responsibility of the IMO, with those costs covered by a tariff on farmers who join the project.

13. Financial investment and O&M cost estimates have been disaggregated into foreign and domestic costs and tax and duty components. Economic costs have been estimated by eliminating taxes and duties and converting the remaining financial values to economic values by applying the standard conversion factor (SCF). The economic prices of tradable outputs (rice) are based on export parity prices, and the economic prices of tradable inputs (fertilizers) are based on import parity prices, estimated based on prevailing World Bank commodity price forecasts.[2] All other project outputs and inputs are assumed to be nontraded, and their economic values are derived from prevailing financial market prices converted by the SCF. The economic cost of electricity has been used to assess the impact of moving from diesel-powered to electric pumps and has been used in with- and without-project crop budgets to determine economic crop gross margins. The financial price of electricity in pump operation is estimated at Tk7.13/kilowatt-hour. Using an economic conversion factor of 2.22, the economic price charged to pump operators is estimated at Tk15.82/kilowatt-hour.[3]

3. Parameters

14. The specific parameters of the method to determine the EIRR include (i) the use of the domestic price numeraire; (ii) constant April 2021 prices and the taka as the unit of account; (iii) an SCF of 0.975 and a corresponding shadow exchange rate factor of 1.03; (iv) a shadow wage rate factor for unskilled labor of 0.75, reflecting the level of unemployment and underemployment in the project area; (v) an opportunity cost of capital against which economic viability is judged assumed at 9%; and (vi) a 30-year cash flow.

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[2] World Bank. 2020. *Commodity Price Forecasts February 2013* (Pink Sheets). Washington, DC.

[3] The economic price of electricity in 2012 was estimated to be Tk10.0/kilowatt-hour, as per ADB. 2012. *Energy Efficiency Improvement Project.* Second Quarterly Report (TA 7642- BAN). Manila. That economic price has been inflated to Tk15.82.

15. An economic analysis was completed for the ongoing project in 2013. In 2021, for the additional financing, updates were made to farm product prices, farm input prices (including parity prices for tradeable farm products, such as rice, and tradeable farm input prices, such as those for fertilizer). Farm yields and input quantities used were assumed to be the same in 2021 as they were in 2013.

4. Economic Internal Rate of Return

16. The expected net present value (ENPV) for the combined ongoing project and additional financing is $24.9 million and the EIRR is 15.4%. This EIRR is lower than the EIRR of 20.9% that was calculated for the ongoing project. Although there will be an increase of $13.2 million in investment cost provided by the additional financing, that additional cost will be offset by positive changes in farm product prices, a lesser increase in farm input prices from 2013 to 2021, and the ability of the assets to deliver irrigation water to an additional 1,000 ha of farmland (the original project was planned for 17,000 ha). The EIRR for the combined ongoing project and additional financing is more than double the current ADB hurdle rate of 9%, indicating that the combined ongoing project and additional financing is economically viable. Table 1 shows the key factors in determining the EIRR; Table 2 shows the changes in crop prices from 2013 to 2021.[4]

Table 1: Key Factors in Determining the Change in Economic Internal Rate of Return from 2013 to 2021

Item	Ongoing Project	Ongoing Project + Additional Financing	Effect	Comment
Increased investment cost	$45.9 million	$59.1 million	$13.2 million	24% increase in project investment
Increase in command area	17,000 hectares	18,000 hectares	$166,000	$156,000 for 1 year is for 0.2 ha farms across 1,000 ha. Present value over 30 years at 9% = $1.7 million
Increase in crop gross margin	$156.0	$166.3	$180,000	Increase in farm gross margin on 18,000 ha for 1 year. Present value over 30 years at 9% = $1.85 million

Source: Asian Development Bank estimates.

Table 2: Changes in Crop Prices from 2013 to 2021 (Tk)

		2013 Prices		2021 Prices	
Agricultural Outputs	**Unit**	**Financial**	**Financial**	**Financial**	**Economic**
Paddy - HYV Boro (Rabi) - Existing Diesel Pump	ton	12,500	16,640	16,640	20,483
Paddy - HYV Boro (Rabi) - Existing Electric Pump	ton	12,500	16,640	16,640	20,483
Paddy - HYV Aman (*Kharif* II)	ton	12,800	16,990	16,990	20,483
Potato (*Rabi*)	ton	12,450	14,960	14,960	12,071
Vegetables (*Kharif* I)	ton	10,000	10,000	10,000	9,695
Pulses (*Rabi*)	ton	55,000	58,000	58,000	53,325
Paddy straw - Paddy - HYV Boro (*Rabi*)	ton	4,800	4,800	4,800	4,654
Paddy straw - Paddy - HYV Aman (*Kharif* II)	ton	8,630	8,630	8,630	8,367

kharif = monsoon season, *rabi* = dry season.
Source: Asian Development Bank estimates.

5. Sensitivity Analysis

17. Sensitivity analysis has been undertaken to assess the impact of potential adverse movements in key variables in the analysis. Switching values were estimated for changes in crop gross margins, project investment costs, and project O&M costs (Table 3).

[4] Supplementary Document (accessible from the list of linked documents in Appendix 2 of the report and recommendation of the President).

Table 3: Switching Values

Item	Change in an Item (%)[a]
Crop gross margins	(33)
Investment costs	75
Operation and maintenance Costs	183

( ) = negative.
[a] Switching values indicate the percentage by which an item can change before the economic internal rate of return is reduced to the level of the opportunity cost of capital (9%), and at which the economic net present value equals zero.
Source: Asian Development Bank estimates.

18. The EIRR is generally robust with respect to adverse changes in benefits and costs. It is more sensitive to changes in crop gross margins, where a decrease of 33% in project benefits will drive the ENPV to zero and the EIRR to 9%—the opportunity cost of capital. An increase in project investment costs would have to be about 75% and an increase in O&M costs would have to be about 183% to drive the ENPV to zero and the EIRR to 9%.

F. Distribution

19. Project beneficiaries are poor farmers in the Muhuri Irrigation Project area. On a 0.2-ha farm, which represents 90% of farms in the Muhuri Irrigation Project area, only *boro* (0.15 ha) and *aman* (0.12 ha) rice crops are cultivated in the without-project scenario, representing a cropping intensity of 135%. Based on *boro* and *aman* crop gross margins under diesel water pumping, the total net return from crop cultivation is estimated to be around Tk3,200 per year. In the with-project scenario, a more diverse cropping pattern is expected with the introduction of potato and vegetable cultivation. This results in a cropping intensity of 184%. Applying the with-project gross margins to these areas results in a total income from crop cultivation of around Tk11,670 per farm per year.

20. The transition to more intensive cultivation that is expected after more effective irrigation is available to farmers is projected to result in an increase in family labor. On the 0.2-ha farms, family labor is projected to increase from 5 days to 11 days per year. In the without-project scenario, the return per day of family labor is estimated at Tk5,400 under diesel pumping. The return per family-labor-day in the with-project scenario is Tk4,320. The result of the change in return per family-labor-day is that with-project returns are more than the prevailing daily agricultural wage, which is estimated at Tk446 in the *rabi* (dry) season and Tk400 in the *kharif* (monsoon) season. However, the limited number of family-days engaged in crop cultivation and the resulting total returns indicate a need for farmers to find alternative sources of income to supplement that from crop cultivation. For 0.2-ha farms, nonfarm income is estimated to be around Tk65,900 annually, compared with Tk11,865 from crop cultivation.

21. Based on the incremental requirement for labor estimated from with- and without-project crop budgets, it is estimated that an additional 1.07 million person-days of agricultural labor will be generated annually. At a daily wage rate of Tk400, this amounts to an additional Tk428 million per year in agricultural workers' incomes. In addition, there is a one-off demand for skilled and unskilled labor during the construction phase of approximately 160,000 person-days of skilled labor and 474,000 person-days of unskilled labor, amounting to revenue of Tk80 million for skilled labor and Tk190 million for unskilled labor (based on an estimated daily rate of Tk500 for skilled labor and Tk400 for unskilled labor).