

ECONOMIC AND FINANCIAL ANALYSIS

A. Approach and Methodology

1. Approach

1. The economic analysis of the Community-Managed Irrigated Agriculture Sector Project – Additional Financing (CMIASP-AF) is based on estimates of incremental benefits that will accrue from investment in the rehabilitation of irrigation infrastructure of selected irrigation schemes (subprojects) in the form of increased crop production. In addition, a financial analysis has been undertaken to assess the impact of irrigation rehabilitation on farm household incomes for a representative farm size in each scheme. Irrigation rehabilitation is expected to lead to an increase in crop yield and, in the longer term, limited diversification of cropping patterns toward more market-oriented, higher-value crops as a result of more effective delivery of irrigation and support to farmers. Over the 20-year period used for the analysis, there are likely to be developments in crop technologies, but the nature of such developments cannot be predicted. However, it is assumed that farmers would adopt any such developments only if they were shown to improve productivity and income. As such, an economic analysis based on current technologies and practices is considered conservative since benefits from crop production may in fact be higher as a result of future developments in agriculture technology.

2. In addition to the direct benefits of incremental crop production, there will be a variety of indirect benefits. Greater availability and diversity of crop residues for animal feed may promote livestock production. Also, agribusiness activity may increase to meet greater demand for farm inputs, and product marketing and processing. On- and off-farm jobs, and economic activity generally, are expected to increase. As a result, the project will have significant economic and social benefits in the areas where project-supported irrigation schemes are located. However, 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. CMIASP-AF will also generate a range of nonquantifiable benefits, such as (i) greater capacity of water user associations (WUAs) and stronger representation of farmers, (ii) improved, participatory irrigation scheme planning, and (iii) better irrigation and related service-delivery mechanisms with transparent and accountable governance. Benefits derived from strengthening the institutional framework for participatory irrigation management and integrated water resource management will also have wider local and national impacts.

3. The economic analysis has been undertaken for four farmer-managed irrigation schemes (FMIS) and an agency-managed irrigation scheme (AMIS). The selected schemes cover the central and eastern development regions, and both the hills and the Terai (southern plains) in each region.¹

2. Methodology

4. The economic analysis compares incremental costs and benefits to derive an economic internal rate of return (EIRR) for selected schemes. Crop budgets, estimated from data on physical inputs and outputs, prices, and related variables, have been prepared to estimate with- and without-project crop gross margins per hectare (ha). The subproject preparation report (SPPR) database of the Department of Irrigation (DOI) provides with- and

¹ The analysis of all five schemes is in the Detailed Economic and Financial Analysis (accessible from the list of linked documents in Appendix 2 of the Report and Recommendation of the President).

without-project cropping patterns, crop yields, and some input and output prices.² Input usage per crop has been derived from schemes implemented under the Asian Development Bank (ADB)-financed Community-Managed Irrigated Agriculture Sector (CMIASP). Additional input and output prices have been derived from data of the Ministry of Agricultural Development (formerly the Ministry of Agriculture and Cooperatives).³ Financial crop budgets have been converted to economic values to determine with- and without-project economic crop gross margins per ha. Economic gross margins per ha have been applied to the with- and without-project cropping patterns, based on crops cultivated and the area under each crop, to derive with- and without-project total (subproject) gross margins. Subproject-wide cropping patterns are based on those in the SPPR database. 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 operation and maintenance (O&M) costs of a scheme in economic terms have been combined to derive a cash flow from which the EIRR is estimated.

5. The economic analysis assumes that in the without-project scenario there will be a continuation of the present situation, in which irrigation is only partially effective or ineffective. This underestimates potential incremental benefits in as far as in many schemes the effectiveness of irrigation delivery and/or the area irrigated has declined in recent years. This may be expected to continue but the rate of future decline is difficult to predict. As such, it has been assumed to be constant, thereby resulting in a more conservative EIRR. With-project economic benefits will derive from more effective irrigation delivery resulting from infrastructure rehabilitation and, in some schemes, an increase in the area irrigated. As such, only irrigated crops are covered by the analysis.⁴ Benefits may also accrue from improved access to better-quality inputs, technology, and extension services but these are also difficult to differentiate with any degree of accuracy and have not been included in the analysis. With-project benefits therefore underestimate the full potential benefits from scheme rehabilitation and project-financed support.

6. To assess the impact of scheme rehabilitation on household incomes, a farm budget has been prepared by applying financial gross margins per ha from crop budgets in financial terms to cropping patterns and crop areas for a representative farm of 0.5 ha for each scheme.⁵ The crop budgets assume that all farm labor is hired, since the SPPRs do not differentiate between hired and family labor. This overstates the monetary cost of labor and means that net income for the farm household is higher than would appear from the farm budget analysis.

7. The rehabilitation of subprojects will generate an increase in labor resulting from increased crop production and a one-off requirement during rehabilitation works. An estimate of incremental farm labor is derived from crop and farm budgets. The need for labor during rehabilitation is estimated on the basis of the cost of rehabilitation works. A review of CMIASP subprojects indicates that rehabilitation costs can be broken down into WUA in-kind

² Basic data are derived from household surveys conducted by DOI in each irrigation subproject area. Supplementary data, e.g., on with-project yields, are provided by the district agriculture development offices. Present cropping patterns are based on field investigations. Proposed cropping patterns are based on consultations between farmers, WUAs, DOI, and district agricultural development offices.

³ Ministry of Agriculture and Cooperatives. 2013. *Cost of Production & Marketing Margin of Cereal, Cash, Vegetable & Spices Crops, Nepal 2069/2070 (2012/2013)*. Kathmandu.

⁴ It is noted that yield increases, on which incremental benefits are based, may result from factors other than irrigation alone, such as access to inputs and markets, extension, and farmer preference. But it is not possible to separately identify the impact of such factors in the data available for the analysis. Many such factors would, however, be induced by improved access to irrigation and/or can be attributed to the project.

⁵ In the absence of a detailed farm survey, the without- and with-project cropping pattern is assumed to be the same as the scheme as a whole.

contribution (4%), WUA paid contribution (18%), and contractors' costs (78%). It is estimated that the proportion of labor, as opposed to materials, for the WUA contribution is 50% and for the contractors' work is 35%. For the contractors' work it is further estimated that 33% is contributed by local unskilled labor and 67% by skilled labor brought in by the contractors. The local, unskilled labor contribution to the total construction cost is therefore estimated at 18%. Based on DOI's average unskilled labor rates of NRs350 per day, an estimate of both the value of additional labor and the number of additional labor days is made for each subproject.

8. Other aspects of the methodology are:

- (i) The use of the domestic price numeraire, following ADB guidelines.⁶
- (ii) Constant mid-2013 prices, and the Nepalese rupee as the unit of account.
- (iii) A standard conversion factor of 0.93 and a corresponding shadow exchange rate factor of 1.08.
- (iv) An economic opportunity cost of capital against which economic viability is judged of 12%.⁷
- (v) A 20-year cash flow to determine the EIRR.
- (vi) The economic prices of tradable outputs (rice, wheat, and maize) and inputs (urea, diammonium phosphate, and potash fertilizers) are based on import parity prices estimated on the basis of prevailing World Bank commodity price forecasts.⁸ All other project outputs and inputs are assumed to be nontraded.⁹
- (vii) The economic cost of labor has been estimated by applying a shadow wage rate factor (SWRF) of 0.7 to the financial cost of labor, to reflect the current situation of surplus labor in rural markets.
- (viii) Financial investment cost estimates¹⁰ provided in DOI's SPPRs have been converted into economic costs by eliminating taxes (value-added tax) as transfer payments with no real economic cost, and eliminating price escalation estimates so as to provide costs in constant terms.
- (ix) Annual economic O&M costs have been estimated at rates of 5% (headworks), 5% (main canal), and 2% (branch canal) of economic scheme rehabilitation costs. They are assumed to begin in the year after completion of rehabilitation works.
- (x) Completion of each FMIS rehabilitation is expected over 2 years, with 50% completion each year. For AMIS rehabilitation, completion is expected over 3 years, with yearly completion rates of 20%, 40%, and 40%.

B. Papawa Khola Irrigation Subproject, Bhojpur District (Eastern-hills)

9. The Papawa Khola scheme has a gross command area (GCA) of 51 ha and a cultivable command area (CCA) of 45 ha. No extension of the CCA is expected after rehabilitation. Cropping intensity at present is 107%. This is expected to rise to 200% after rehabilitation. Changes in cropping patterns and increases in yield will result in significant

⁶ ADB. 1993. *Guidelines for the Economic Analysis of Projects*. Manila (updated from time to time).

⁷ ADB. 2003. *Key Areas of Economic Analysis of Projects – An Overview*. Manila.

⁸ World Bank. 2013. *Commodity Price Forecast Update Released: July 08 2013*. Washington, DC.

⁹ Financial and economic prices and parity price estimates are presented in the Detailed Economic and Financial Analysis (accessible from the list of linked documents in Appendix 2).

¹⁰ Investment costs are broken down into headworks, and main and branch canal works. In addition, they include (i) general items comprising insurance, preparation of detailed drawings, and performance bond; and (ii) other expenditure items comprising work charges, other minor expenses, construction supervision, integrated crop and water management programs, environmental management, agricultural development, and physical and price contingencies.

increases in crop production—up to 50 tons (rice), 17 tons (wheat), and 21 tons (maize) per year. The production of potatoes and vegetables together is expected to increase by 146 tons per year. The total incremental value of all crops is expected to be almost NRs12 million per year.

10. The financial cost of rehabilitating Papawa Khola is estimated to be NRs15.2 million. Economic costs are estimated at NRs12.8 million. Annual economic O&M costs are estimated at NRs0.05 million for headworks and NRs0.40 million for the main canal, totalling NRs0.45 million.

11. The EIRR of scheme rehabilitation is estimated to be 31.7%. Sensitivity analysis indicates that the proposed rehabilitation is robust with respect to adverse changes in cost and benefits. Under the base-case scenario, rehabilitation is expected to be completed within 2 years and incremental crop benefits to begin to accrue in the following year. Assuming the same phasing of rehabilitation works but a 2-year delay in the start of incremental benefits, the EIRR would fall to 21.0%. A higher economic cost of labor, based on an SWRF of 0.9 rather than 0.7, would reduce the EIRR to 29.9%.

12. On a representative 0.5 ha farm, applying the without-project and with-project financial gross margins to the assumed crop areas results in a total net income from crop cultivation of around NRs5,800 before rehabilitation and NRs48,930 after rehabilitation. This results from a shift in the cropping pattern from cereal crops (with the exception of paddy) to higher-value vegetables, pulses, and oilseeds, for which with-project financial gross margins are significantly higher than without-project gross margins. Although the analysis indicates that the financial gross margin for paddy declines after rehabilitation, due in particular to greater use of chemical fertilizers, farmers are likely to continue to cultivate paddy for reasons of food security.

13. Improved irrigation is expected to result in an increase in labor engaged for crop cultivation, notably for harvesting due to expected higher yields. Based on the incremental requirement for labor estimated from with- and without-project crop budgets and the with-project farm cropping pattern, the total increase in the number of days of labor required on the 0.5 ha farm is 50. For the subproject as a whole, the incremental labor requirement is estimated at 4,517 days. At an average daily wage rate of NRs350, this amounts to an additional NRs1.58 million per year in agricultural workers' incomes. In addition, the one-off demand for unskilled labor in the subproject area during rehabilitation is estimated to have a value of NRs1.63 million. This equates to approximately 4,660 person-days.

C. Bhaluwa Irrigation Subproject, Morang District (Eastern–Terai)

14. The Bhaluwa scheme has a GCA of 338 ha and a CCA of 312 ha. No extension of the CCA is expected after rehabilitation. Cropping intensity at present is 140%. This is expected to rise to 185% after rehabilitation. Changes in cropping patterns and increases in yield will result in significant increases in crop production—up to 300 tons (rice), 155 tons (wheat), and 113 tons (maize) per year. The production of potatoes and vegetables together is expected to increase by 822 tons per year. The total incremental value of all crops is expected to be almost NRs76 million per year.

15. The financial cost of the Bhaluwa rehabilitation is estimated at NRs65.1 million, and economic costs at NRs53.7 million. Annual economic O&M costs are estimated at NRs1.75 million for headworks, NRs0.37 million for the main canal, and NRs0.02 million for the branch canal, totalling NRs2.14 million.

16. The EIRR of scheme rehabilitation is estimated to be 40.3%. Sensitivity analysis indicates that the proposed rehabilitation is robust with respect to adverse changes in cost

and benefits. Under the base-case scenario, rehabilitation is expected to be completed within 2 years and incremental crop benefits to begin to accrue in the following year. Assuming the same phasing of rehabilitation works but a 2-year delay in the start of incremental benefits reduces the EIRR to 25.5%. A higher economic cost of labor, based on an SWRF of 0.9 rather than 0.7, would reduce the EIRR to 38.9%.

17. On a representative 0.5 ha farm, applying the without-project and with-project financial gross margins to the assumed crop areas results in a total net income from crop cultivation of around NRs23,740 before rehabilitation and NRs61,260 after rehabilitation. This results from a shift in the cropping pattern from cereal crops (with the exception of monsoon paddy) to higher-value vegetables and oilseeds, for which with-project financial gross margins are higher than without-project gross margins. Although the analysis indicates that the financial gross margin for paddy declines after rehabilitation, due in particular to greater use of chemical fertilizers, farmers are likely to continue to cultivate paddy for reasons of food security.

18. Improved irrigation is expected to result in an increase in labor engaged for crop cultivation, notably for harvesting due to expected higher yields. Based on the incremental requirement for labor estimated from with- and without-project crop budgets and the with-project farm cropping pattern, the total increase in number of days of labor required on the 0.5 ha farm is 27. For the subproject as a whole, the incremental labor requirement is estimated at 16,512 days. At an average daily wage rate of NRs325, this amounts to an additional NRs5.37 million per year in agricultural workers' incomes. In addition, the one-off demand for unskilled labor in the subproject area during rehabilitation is estimated to have a value of NRs7.79 million. This equates to approximately 22,250 person-days.

D. Cha Khola Maitakunta Irrigation Subproject, Kavrepalanchowk District (Central-hills)

19. The Cha Khola Maitakunta scheme has a GCA of 55 ha and a CCA of 54 ha. No extension of the CCA is expected after rehabilitation. Cropping intensity at present is 152%. This is expected to rise to 250% after rehabilitation. Changes in cropping patterns and increases in yield will result in significant increases in crop production—up to 100 tons (rice) and 26 tons (maize) per year—although wheat production is expected to fall by 14 tons per year. The production of potatoes and vegetables together is expected to increase by around 750 tons per year. The total incremental value of all crops is expected to be almost NRs29 million per year.

20. The financial cost of the Cha Khola Maitakunta rehabilitation is NRs16.7 million compared with economic costs of NRs14.1 million. Annual economic O&M costs are estimated at NRs0.11 million for headworks and NRs0.39 million for the main canal, totalling NRs0.50 million.

21. The EIRR of scheme rehabilitation is estimated to be 57.1%. Sensitivity analysis indicates that the proposed rehabilitation is highly robust with respect to adverse changes in cost and benefits. Under the base-case scenario, rehabilitation is expected to be completed within 2 years and incremental crop benefits to begin to accrue in the following year. Assuming the same phasing of rehabilitation works but a 2-year delay in the start of incremental benefits, the EIRR would fall to 34.0%. A higher economic cost of labor, based on an SWRF of 0.9 rather than 0.7, would reduce the EIRR to 54.4%.

22. On a representative 0.5 ha farm, applying the without-project and with-project financial gross margins to the assumed crop areas results in a total net income from crop cultivation of around NRs54,550 before rehabilitation and NRs149,100 after rehabilitation.

This results from both an improvement in financial gross margins and, in particular, from an increase in cropping intensity from 152% to 259%.

23. Improved irrigation is expected to result in an increase in labor engaged for crop cultivation, notably for harvesting due to expected higher yields. Based on the incremental requirement for labor estimated from with- and without-project crop budgets and the with-project farm cropping pattern, the total increase in the number of days of labor required on the 0.5 ha farm is 87. For the subproject as a whole, the incremental labor requirement is estimated at 3,086 days. At an average daily wage rate of NRs350, this amounts to an additional NRs1.08 million per year in agricultural workers' incomes. In addition, the one-off demand for unskilled labor in the subproject area during rehabilitation is estimated to have a value of NRs1.82 million. This equates to approximately 5,190 person-days.

E. Meghakhola Irrigation Subproject, Parsa District (Central–Terai)

24. The Meghakhola scheme has a GCA of 220 ha and a CCA of 205 ha. No extension of the CCA is expected after rehabilitation. Cropping intensity at present is 188%. This is expected to rise to 194% after rehabilitation. Changes in cropping patterns and increases in yield will result in significant increases in crop production—up to 262 tons (rice) and 84 tons (wheat) per year. The production of maize is expected to decline by 48 tons, while vegetable production is expected to rise by 150 tons per year and potato production by 130 tons. The total incremental value of all crops is expected to be almost NRs64 million per year.

25. The financial cost of rehabilitating Meghakhola is estimated at NRs50.3 million, and economic costs at NRs41.6 million. Annual economic O&M costs are estimated at NRs0.57 million for headworks, NRs0.85 for the main canal, and NRs0.10 million for the branch canal, totalling NRs1.52 million.

26. The EIRR of scheme rehabilitation is estimated to be 29.6%. Sensitivity analysis indicates that the proposed rehabilitation is reasonably robust with respect to adverse changes in cost and benefits. Under the base-case scenario, rehabilitation is expected to be completed within 2 years and incremental crop benefits to begin to accrue in the following year. Assuming the same phasing of rehabilitation works but a 2-year delay in the start of incremental benefits would reduce the EIRR to only 19.7%. A higher economic cost of labor, based on an SWRF of 0.9 rather than 0.7, would reduce the EIRR to 29.1%.

27. On a representative 0.5 ha farm, applying the without-project and with-project financial gross margins to the assumed crop areas results in a total net income from crop cultivation of around NRs59,490 before rehabilitation and NRs92,260 after rehabilitation. This results from a shift in the cropping pattern from maize and spring wheat to higher-value vegetables and potatoes, for which with-project financial gross margins are significantly higher than without-project gross margins.

28. Improved irrigation is expected to result in an increase in labor engaged for crop cultivation, notably for harvesting due to expected higher yields. Based on the incremental requirement for labor estimated from with- and without-project crop budgets and the with-project farm cropping pattern, the total increase in the number of days of labor required on the 0.5 ha farm is 10. For the subproject as a whole, the incremental labor requirement is estimated at 988 days. At an average daily wage rate of NRs350, this amounts to an additional NRs0.35 million per year in agricultural workers' incomes. In addition, the one-off demand for unskilled labor in the subproject area during rehabilitation is estimated to have a value of NRs5.97 million. This equates to approximately 17,050 person-days.

F. Attrauliputar Irrigation Subproject, Tanahun District (Western Region)

29. The Attrauliputar scheme has a GCA of 560 ha and a CCA of 450 ha. No extension of the CCA is expected after rehabilitation. Cropping intensity at present is 201%. This is expected to rise to 255% after rehabilitation. Changes in cropping patterns and increases in yield will result in significant increases in crop production—up to 315 tons (rice), 135 tons (wheat), and 338 tons (maize) per year. The production of potatoes and vegetables together is expected to increase by 113 tons per year. The incremental value of rice, wheat, and maize production in financial terms is estimated to total NRs41.0 million per year. The incremental value of potatoes and vegetables is expected to be NRs2.8 million per year.

30. The financial cost of rehabilitating Attrauliputar is estimated at NRs165.6 million, and economic costs at NRs136.2 million. Annual economic O&M costs are estimated at NRs0.25 million for headworks, NRs2.91 million for the main canal, and NRs0.98 million for the branch canal network, totalling NRs4.14 million.

31. The EIRR of scheme rehabilitation is estimated to be 36.0%. Sensitivity analysis indicates that the proposed rehabilitation is robust with respect to adverse changes in key variables. Under the base-case scenario, rehabilitation is expected to be completed within 3 years and incremental crop benefits to begin to accrue in the following year. If completion of rehabilitation and, therefore, the start of incremental benefits were to be delayed by 2 years, the EIRR would fall to 24.3%. A higher economic cost of labor, based on an SWRF of 0.9 rather than 0.7, would reduce the EIRR to 35.3%.

32. On a representative 0.5 ha farm, applying the without-project and with-project financial gross margins to the assumed crop areas results in a total net loss from crop cultivation of around NRs1,500 before rehabilitation and a total net income of NRs31,880 after rehabilitation. This results from a shift in the cropping pattern from low-value pulses to paddy in the monsoon season, and from an increase in the area under higher-value vegetables and potatoes, for which with-project financial gross margins are significantly higher than without-project gross margins.

33. The increase in yields associated with improved irrigation is expected to result in an increase in labor engaged in crop harvesting. Based on the incremental requirement for labor estimated from with- and without-project crop budgets and the with-project project-wide cropping pattern, the total increase in the number of days of labor required on the 0.5 ha farm is 31. For the subproject as a whole, the incremental labor requirement is estimated to be 28,688. At a daily wage rate of NRs350, this amounts to an additional NRs10.04 million per year in agricultural workers' incomes. In addition, the one-off demand for unskilled labor in the subproject area during rehabilitation is estimated to have a value of NRs1.63 million. This equates to approximately 4,655 person-days.

G. Summary

34. The improvement in irrigation delivery will result in increases in crop yields and a shift in cropping patterns to higher-value crops. Overall, expectations are for an increase in the production of cereals of around 100 tons per year for FMIS in the hills, and of 480 tons per year for those in the Terai. In the larger AMIS, cereal production is expected to increase by almost 800 tons per year. Incremental production of vegetables varies significantly across schemes but is expected to be in the range of 100–800 tons per year. Annual increases in the value of production across all schemes range from NRs12 million to NRs76 million.

35. The annual increase in the value of crop production far exceeds the annual increase in scheme O&M costs. In the worst-case scenario, for the AMIS, the annual incremental value of crop production is around 10 times the annual increase in scheme O&M cost. This

will ensure the financial sustainability of scheme rehabilitation. This is supported by the farm income analysis, which indicates that farm households will benefit from better irrigation delivery, with net farm incomes increasing by between 160% and 760%. Farm households will be able to finance the higher O&M costs associated with rehabilitated irrigation infrastructure through their contributions to WUAs. This will complement the initial contributions made by farmers through WUAs to construction costs, thereby enhancing the commitment of farmers to scheme rehabilitation and future O&M, and long-term financial sustainability, which will preclude the need for more government financing.

36. The table below summarizes the economic analysis and sensitivity analysis for each subproject.

Summary Economic and Sensitivity Analyses					
Item	Papawa Khola	Bhaluwa	Cha Khola Maitakunta	Meghakhola	Attrauliputar
EIRR	31.7	40.3	57.1	29.6	36.0
Switching Values					
Benefits	56	65	77	53	65
Investment	161	242	430	140	226
O&M	633	842	1,667	533	1,056
Delay 1 year ^a	25.2	31.1	42.2	23.6	28.9
Delay 2 years	21.0	25.5	34.0	19.7	24.3
SWRF 0.5 ^b	33.4	41.6	59.8	30.1	36.8
SWRF 0.9	29.9	38.9	54.4	29.1	35.3

EIRR = economic internal rate of return, O&M = operation and maintenance, SWRF = shadow wage rate factor.

^a Delay in the attainment of benefits after completion of rehabilitation.

^b Variation of the base-case value of the SWRF of 0.7.

37. Rehabilitation is shown to be economically viable for all subprojects analysed. The sensitivity analysis indicates that all schemes are robust with respect to adverse changes in benefits and costs. Only where there are delays in the attainment of benefits does the EIRR fall significantly, but still not to a level close to the economic opportunity cost of capital. Such delays in the attainment of incremental benefits from crop production without a corresponding delay in the completion of scheme rehabilitation are not considered plausible. An economic cost of labor closer to its financial cost equivalent to the rural labor wage rate has only limited impact on subproject EIRRs and does not significantly affect viability.

38. The results of the analyses of these sample schemes provide an indication that all schemes proposed for implementation under the CMIASP-AF will be economically viable and financially sustainable. All schemes should, however, be subjected to economic analysis during project implementation before starting the rehabilitation process.