ECONOMIC ANALYSIS

A. Introduction

1. The economy of Nepal remains largely dependent upon the agricultural sector, which employs about 65% of the population and contributes around 25% of the nation's gross domestic product.[1] With the rural population being almost 80% of the total 30.5 million people, the reliance upon agriculture for employment in rural areas is significantly higher than the national average. Agriculture is also a major contributor to Nepal's exports ranging from 27% of total merchandise exports in 2015 to 49% in 2022 (with a peak 67% in 2021). Poverty remains a problem in Nepal with a national multidimensional poverty index of 17.4% reported in 2017 (latest World Bank Indicator data). Since poverty in Nepal is a predominantly rural phenomenon, improving agricultural productivity is instrumental to improving the living conditions of Nepal's impoverished rural areas. Food insecurity is an ongoing concern with the prevalence of severe food insecurity ranging from 10%–14% between 2015 and 2021, and moderate food security ranging from a low of 29%–38% (footnote 1). Nepal also remains highly dependent upon imported food (mostly from India), with on average around 20% of merchandised imports being food imports.

2. The area of Nepal recorded as agricultural land is 41,210 kilometers, which is around 28.7% of total area (footnote 1). Arable land (entirely irrigated) is 14.7% of the total area. Hence Nepal has significant land constraints that affect its ability to increase agricultural production and improve food security conditions. To alleviate these problems requires an increase in agricultural productivity, largely through improved irrigation infrastructure and management.

3. The Irrigation Modernization Enhancement Project (IMEP) will contribute to addressing these problems by rehabilitating and developing irrigation infrastructure in the terai and hill irrigation systems of Nepal. The project will (i) rehabilitate at least 34 terai (12,000 hectare [ha]) and 53 hill (6,000 ha) minor farmer managed irrigation systems (FMIS) in Bagamati, Koshi, Madesh provinces, (ii) rehabilitate key infrastructure in Rajapur Irrigation Project (14,500 ha) in Lumbini Province, and (iii) construct 12 pilot new hill lift irrigation systems irrigating around 1,400 ha in the river basin areas of Gandaki and Lumbini provinces. The project will also support the establishment of new and strengthening of existing water user associations (WUAs) and provide support for improved and climate resilient agriculture targeting of the rehabilitated schemes.

B. Rationale

4. The rationale for the IMEP is based on the principles of market failure as the socially optimal level of water supply for rural communities is unlikely to be met by the private sector. This is due to (i) the substantive capital costs involved, and (ii) as farmers are exempt from paying full-cost recovery of irrigation water charges there is no mechanism to generate revenues to provide a sufficient financial return as required by private sector investment. Without some form of public intervention the market will construct fewer (or none) irrigation water infrastructure than is optimal from a societal point of view. Hence, government intervention is justified to upgrade existing and develop new infrastructure, however cost sharing through beneficiary contribution is proposed within the project structure. Moreover, beneficiaries and communities will undertake greater responsibility for operation and maintenance (O&M) through strengthening existing and creating new WUAs.

[1] World Bank. World Development Indicators: Nepal (accessed 1 July 2024).

C. Demand Analysis

5. The agriculture sector of Nepal is dominated by subsistence farming and low productivity which contributes to the country's food security vulnerability. Low agricultural productivity is largely due to (i) unreliable access to water and a lack of irrigation services and (ii) system inefficiencies. Not only is production reduced in irrigated areas but many productive uplands along river valleys remain barren due to lack of water for gravity irrigation. Climate change is impacting rainfed and irrigated crops with delayed monsoon, longer dry and wetter wet seasons, and increasing frequency of extreme climatic events.[2]

6. Many of the irrigation systems, particularly FMIS, are up to a century old. They suffer from non-engineered design, lack of on-field water distribution system for water use efficiency, and weak capacity of farmers in system management and equitable water distribution. Hence, investments are needed to rehabilitate the systems, improve the efficiency of old systems, and significantly strengthen the agriculture and irrigation institutions at the field level.

7. In addition to improving cropping intensities and yields, reliable irrigation water will allow farmers to switch from low-value cereal crops to high-value crops (such as fruits and vegetables) as per market demands.[3] Nepal has 2.54 million ha of cultivable land, of which 1.44 million ha has access to irrigation. Consequently, it is concluded that there is substantive unmet demand for irrigation water that can be generated from investment in the IMEP.

D. Alternatives Analysis

8. A considerable number of FMIS were evaluated for technical viability, from which around 100 were selected and assessed for economic viability in accordance with ADBs guidelines. Following this process, 34 terai FMIS schemes and 53 hill FMIS schemes were primarily identified as meeting ADB's requirements for economic viability. Subsequently, 20 of the terai schemes (7,137 ha) and 37 of the hill schemes (3,005 ha) had detailed design and cost estimates and to meet ADB project readiness requirements were included in the first stage of implementation. The same process was applied to hill lift irrigation schemes with 12 schemes (1,415 ha) being assessed as economically viable and thus included in the project design. Finally, 34 terai schemes (11,563 ha), 66 hill schemes (5,889 ha), 12 hill lift irrigation schemes (1,415 ha) and Rajapur (14,500 ha) were included in project overall economic viability analysis.

E. Cost-Benefit Analysis

9. **Key Assumptions**. The economic analysis of the project investments was conducted in accordance with ADB's 2017 guidelines for economic analysis.[4] The following key assumptions and data were adopted for converting financial values to their equivalent economic equivalent and deriving an economic internal rate of return (EIRR) and economic net present value:

(i) the analysis is based on 2024 constant prices and uses a domestic numeraire and a shadow exchange rate factor (SERF) of 1.24 to convert financial values to an economic equivalent;

(ii) the official exchange rate is NRs132.95: $1.00 (20 January 2024), and the shadow

[2] The Department of Hydrology Meteorology data suggest that the temperature across the country shows an increasing trend of up to 0.55°C per decade, which is higher than the global warming rate.

[3] Increased demand for high value crops is because of (i) increase in level of education and awareness about nutritive values of fruits and vegetable, (ii) rise in income level of people mainly through remittance, (iii) increase in fruit and vegetable area and production due to government thrust on their cultivation since early 1970.

[4] ADB. 2017. *Guidelines for the Economic Analysis of Projects*.

exchange rate was calculated as NRs141.79: $1:00;

(iii) the shadow wage rate factor (SWRF) was 0.81. Skilled labor was valued at its financial price and unskilled labor was derived by applying the SWRF to the financial value of unskilled labor;

(iv) the economic costs of traded goods were adjusted by the SERF and included border prices for crop outputs and some inputs such as chemicals and fertilizer; non-traded goods were valued at the financial price, excluding any taxes or transfer payments;

(v) an economic life of 25 years was adopted; and

(vi) the discount rate applied was 9%.

10. **Project Costs**. Financial costs were derived for each irrigation scheme for (i) civil works, (ii) non-civil works, and (iii) O&M. For the hill FMIS schemes and terai FMIS schemes civil works included construction items such as headworks, canal works, cross drainages, protection works, other structures, general items, and WUA contributions. The nature of works for Rajapur Irrigation Project differed with the following construction items—intakes, sediment control, irrigation development, protection works, pilot groundwater scheme, general items, and WUA contribution. The hill lift schemes likewise had different construction items—intakes, storage tanks, pumps and/or accessories, electrical and mechanical, distribution system, general items, and beneficiaries' contributions. Identification of the various cost items is important for the conversion of financial to economic values as each item will have a differing level of local and foreign materials (SERF applied) and skilled and unskilled labor (SWRF applied).

11. Non-civil works costs include investments in capacity building, agricultural support, procurement of goods, and institutional systems. Price and physical contingencies are included and calculated for each category determining the base costs. Annual O&M costs for the hill FMIS and terai FMIS schemes were estimated at 2% of the total civil works cost. For Rajapur Irrigation Project, the O&M was estimated at 3% of total civil works cost. For each hill lift irrigation scheme, a flat rate of NRs22,592 per annum was applied for annual O&M.

12. The conversion of financial cost values to their economic equivalent was accomplished by the application of the ratios of materials and labor costs as a proportion of total costs. Material costs were disaggregated into local and foreign components, with the SERF applied to the cost values of the foreign component. Labor costs were disaggregated into skilled and unskilled components, with the SWRF being applied to the values of the unskilled component.

13. The determination of financial and economic costs for the aggregate schemes is presented in Table 1. The economic costs were derived by (i) removing price contingencies, taxes and other transfer payments, and (ii) applying the cost breakdowns for materials (local, foreign) and labor (skilled, unskilled), and application of the relevant SERF and SWRF values. This results in a total economic cost of NRs15,087 million, represented by (i) NRs8,108 million for the hill and terai FMIS schemes, (ii) NRs1,799 million for the hill-lift irrigation schemes, and (iii) NRs5,180 million for the Rajapur Irrigation Project.

Table 1. Financial and economic costs of the IMEP (NRs million)

	Civil works	Non-civil works / O&M	Contingencies	Total
Financial values	11,427	3,953	2,132	17,511
Economic values	10,142	3,855	1,090	15,087

OM = operation and maintenance
Source: Asian Development Bank.

14. **Project Benefits**. The project incremental benefits were derived by measuring the change in the value of crop production between "with-project" and "without-project" scenarios. Improving irrigation water supply in the schemes will (i) increase the cropping intensity on existing cultivated lands, (ii) increase in crop yields due to more secured supply of water (particularly in comparison to rainfed systems), and (iii) increase the production of high value crops (e.g., vegetables, perennial crops) instead of low value crops (e.g., paddy). The changes in crop areas and cropping intensity across the schemes is presented in Table 2. This reflects not just the increase in expected areas, but also the shift in production in the winter and spring seasons and to higher value annual crops and vegetables (in monsoon, winter and spring seasons).

Table 2. Change in crop areas (ha) and cropping intensity (%)

	Hill FMIS schemes		Terai FMIS schemes		Rajapur Irrigation Project		Hill-lift irrigation schemes	
	wop	wp	wop	wp	wop	wp	wop	wp
CCC	5,889	5,889	11,563	11,563	14,500	14,500	1,415	1,415
Season:								
• monsoon	5,649	5,882	11,238	11,473	14,210	14,500	1,278	1,396
• winter	2,831	4,491	5,759	10,108	14,065	14,500	648	1,249
• spring	1,437	2,427	1,212	3,107	6,632	5,960	419	913
Annual crops	208	265	25	35	0	574	112	186
Total area	9,917	12,799	18,209	24,688	31,610	34,960	2,228	3,558
CI (%)	168%	217%	157%	214%	219%	246%	164%	251%

CCC = command cultivable area; CI = cropping intensity; FMIS = farmer managed irrigation system; wop = without project; wp = with project.
Source: Asian Development Bank.

15. The project will also result in increased crop yields as production switches from rainfed and/or irrigated systems to fully irrigated. It is not possible to present a detailed table of crop yields for the two scenarios as they are specific to each crop, season type and irrigation scheme. However, some examples (for hill FMIS) include (i) monsoon paddy – 2.9 tons per hectare (t/ha) (without project), 3.4 t/ha (with project); (ii) winter wheat – 2.3 t/ha (without project), 3.0 t/ha (with project), (iii) spring maize – 2.3 t/ha (without project), 2.96 t/ha (with project). Trends in yield increases for other crops and irrigation schemes follow a similar trend, increasing in the range of 10%–40%. The exception is the Rajapur Irrigation Project scheme where there are minimal yield increases and most benefits are due to increased cropping intensity following improved security of water supply.

16. Crop commodities (inputs and outputs) were identified as being either tradeable or non-tradeable. For tradeable commodities economic prices were derived from calculating border prices. The economic prices of non-tradeable commodities were based upon market prices, which were then excluded of taxes and any identified transfer payments. Production costs and gross margin budgets were calculated for each crop and/or season type, with financial values converted to economic equivalent by the process described above.

17. **Results**. The benefit-cost analysis derived an EIRR of 15.7% and an economic net present value of NRs6,420 million for the IMEP. The combined results for the hill FMIS (EIRR 15.5%), terai FMIS (EIRR 14.4%), hill-lift irrigation schemes (EIRR 12.8%) and Rajapur Irrigation Project (EIRR 18.0%) are reported in Table 3. These results suggest that the proposed investments in the IMEP are economically efficient as the calculated EIRRs exceed the minimum ADB threshold of 9%.

Table 3: Economic analysis results for IMEP

	EIRR (%)	ENPV (NRs million)
Hill FMIS	15.5	1,288
Terai FMIS	14.4	1,762
Hill-lift schemes	12.8	426
Rajapur Irrigation Project	18.0	3,005
Total Project	15.7	6,420

EIRR = economic internal rate of return, ENPV = economic net present value, FMIS = farmer managed irrigation system.
Source: Asian Development Bank.

F. Risk and Sensitivity Analysis

18. Sensitivity analysis was applied to changes in (i) civil works costs, (ii) incremental agricultural benefits, and (iii) a 2-year delay in achieving project benefits (Table 4). This indicates that the overall project remains viable to a 20% increase in civil works cost (EIRR switching value of +75%), while economic viability was more sensitive to a 20% decrease in project benefits (EIRR switching value of -33%).

Table 4. Sensitivity analysis (%)

	Hill FMIS	**Terai FMIS**	**Hill-lift schemes**	**Rajapur Irrigation Project**	**Total Project**
Base result (EIRR)	15.5	14.4	12.8	18.0	15.7
+ 20% civil works cost (EIRR)	13.1	12.2	10.4	15.6	13.3
- 20% incremental benefits (EIRR)	11.7	10.6	9.2	13.7	11.7
2-year delay achieving benefits (EIRR)	11.4	10.6	9.4	13.0	11.3
SV – civil works cost increase	68.0	56.0	26.0	71.0	75.0
SV – benefit decrease	-32.0	-27.0	-16.0	-40.0	-33.0

EIRR = economic internal rate of return, FMIS = farmer managed irrigation system, SV = switching value
Source: Asian Development Bank.

G. Distribution and Poverty Analysis

19. A distribution analysis and poverty impact assessment was carried out with project externalities assumed to be distributed among the key stakeholders of government and economy, project beneficiary households, skilled and unskilled labor force, and suppliers of project construction inputs. It was assumed that 28% of project beneficiaries of IMEP are poor, in-line with the estimates of the proportion of poor in rural areas in Nepal.

20. The distribution analysis result indicates that out of the total net project benefit NRs8,444 million, farm households benefit by 54.1%, skilled labor force by 2.6%, unskilled labor force by 22.6% and suppliers by 20.8%. Government and/or economy bears a net cost of 43.5% of the total benefit. The poverty impact ratio was calculated at 49.3% which indicates that a large proportion of the total project net benefit goes to the poor.