

ECONOMIC AND FINANCIAL ANALYSIS

A. Background

1. The Karnataka Integrated and Sustainable Water Resources Management Investment Program will contribute to the improved management and sustainability of increasingly scarce water resources in selected river basins. It will establish and strengthen state and basin level institutions for integrated water resources management (IWRM) and improve irrigation service delivery through system modernization and strengthening of water users cooperative societies (WUCSs). The economic rationale for the program is that economic benefits of improved water supplies are not likely to be obtained without Government of India and/or State Government of Karnataka investment. Improved water resources management and planning will provide water savings that can be used elsewhere.

2. The Gondi subproject is to be modernized under project 1 and is the sample subproject to demonstrate economic and financial benefits. It comprises a weir and two main irrigation canals on the Bhadra River. The subproject has a culturable command area of 4,600 hectares (ha).¹ It is located in Shimoga district and has nine WUCSs. Of about 60% of the cultivable command area (CCA), 3,076 ha is under perennial crops (areca nut 49%, sugar 12%) and most of the remaining area is cropped to kharif and rabi paddy rice (38% of the command area).² Marginal farmers make up 60%–70% of farmers, and there are no large farms. Pumped water for conjunctive use is utilized by farmers in the middle and tail reaches. Pumping costs are excluded from the analysis as these are negligible. The irrigation system is in poor condition. The right main canal is blocked with sediment and cannot convey water. Below kilometer (km) 45, water comes from the Bhadra system as overland flow and intercepted drainage. The downstream 40% of the Gondi system is therefore vulnerable to water shortage when the Bhadra system is not operating. The primary objectives of the modernization include (i) supply of canal water to the lower reaches of Gondi canal, and (ii) saving water that is to be transferred to a newly constructed irrigation area in the Upper Bhadra command.

3. Financial analysis for the Gondi subproject is undertaken to assess the impact on the farm incomes of intended beneficiaries and their ability to contribute to operation and maintenance (O&M) requirements. The economic analysis is conducted to quantify the economic benefits and costs as a basis for assessing the subproject's economic viability and sustainability in the long term. Project institutional benefits are excluded, but are expected to be substantial. The WUCS and Karnataka Neeravari Nigam Limited (KNNL) will continue to maintain systems through WUCS contributions and state budget support. KNNL and AC-IWRM are not directly responsible for loan repayment, which will be from the state. Overall, the state shows good fiscal health with a gross state domestic product for FY2012 of over \$97.1 billion and a declining trend in fiscal deficit from 3.24% (in FY2010) to 2.92% (in FY2012). The repayment of \$150 million is not considered to pose a serious debt burden on the state.

B. Financial Analysis

1. Methodology

4. The financial analysis used late 2012 values, at Rs55 = \$1. Government of India administered prices (crop outputs and fertilizers, in particular) are below world price levels, but

¹ The culturable command area is the all land of the gross command on which cultivation is possible.

² Kharif refers to the refers to the planting, cultivation and harvesting of any plant sown in the rainy season on the Asian subcontinent. Rabi refers to the refers to agricultural crops sown in winter and harvested in the spring.

output market prices are above the administered price (minimum support price). Project outputs were modeled with and without the project, using crop budgets developed in FARMOD 4.02.³ Sharecropping and leasing land constitute less than 1% of area, not modeled. Labor costs are about Rs210 per day (Rs250 for men and Rs150 for women) in 2012. Farmers are adopting mechanization and low labor technologies, while livestock ownership and animal draught are reducing. The Gondi scheme is fully developed, with almost 100% cropping in Kharif and Rabi seasons and a large area of perennial crops. Use of high yielding variety, fertilizers, and crop chemicals is widespread yield rates are quite high; and the potential for incremental increase in yield is limited to 30%.

5. The data sources are (i) project preparatory technical assistance (PPTA) 2012 socioeconomic baseline surveys; (ii) WUCS records and block data from the Agricultural Census, 2005; (iii) crop budgets from crop budget publications;⁴ (iv) data provided by a local nongovernment organization;⁵ (v) secondary data and farmer discussions; (vi) crop area estimates from socioeconomic survey data and 2011 satellite imagery; and (vii) scheme development costs from the detailed project report (KNNL 2013) estimates.

C. Development Costs

6. Construction and command area development works are assumed to start in 2014 and will be completed in 2016. Total costs are Rs1,406 million, including command area development works (Rs190 million), contingencies, overheads, and social development. Institutional strengthening costs are excluded from scheme costs. O&M costs were estimated from the CCA at Rs800 per hectare per year, with and without the project. If channels are not lined, it is assumed that O&M costs for the unlined percentage of the channels increases by 25%. No pumping costs are included in the model, but they are minimal. Water charges are paid by farmers (in 2013 Rs250/ha paddy, Rs1,000/ha sugar, and Rs150/ha for garden [tree] crops) and are included in the crop budget models.

D. Benefits

1. Crop Budgets and Production Costs

7. The PPTA Feasibility Studies Supplementary Report, Financial and Economic Analysis Markets and Prices (Supplementary Appendix 1) details the prices used in the analysis and informs this report. The cropping calendar is typical for the Indian subcontinent, with rabi and kharif rice, and perennial crops, harvested in late kharif. Crop budgets were prepared for kharif and rabi rice, other semidry crops (maize), sugarcane, and areca nut. Key inputs were related to yield. Summary financial budgets by crop are in Supplementary Appendix 1. Perennial crops have positive financial, and usually economic, returns at current prices. Paddy rice inputs and labor are about twice the state average, but yields can be increased through the introduction of the system of rice intensification (SRI). New areca nut plantations are uneconomic due to the lengthy time to commence production but these may form a good long term investment. SRI rice is being adopted in Karnataka, and is expected to be introduced under the Gondi subproject. Data are scarce but research suggests that adoption of all four key SRI

³ Software package designed to generate crop area, farm-family household and project planning data,

⁴ Department of Agriculture, State Government of Karnataka. *Report on Region-wise Cost of Cultivation of Crops 2006-07*. Bangalore.

⁵ The NGO which facilitated data collection is Jalaspandana (or South India Farmers Organization for Water Management), Bangalore, Karnataka.

methodologies in Karnataka will increase yields by 25%, while operating costs will only increase 2.5% and water savings will be significant.⁶

2. Farmer Distribution and Farm Models

8. The Gondi subproject comprises about 3,900 farming households (Table 1). Farm models were prepared for marginal, small, and medium farmers using the average farm size, with a minimum of 0.2 ha of rice for subsistence requirements (half the area of a marginal farm). Farm family labor was assumed to be 1.6 persons, available 25 days/month for all households.

Table 1: Farmer Distribution and Areas, 2012

Farm Type	Households	Mean Farm Size (ha)	Total Area (ha)	Percent of area
Marginal (up to 1 ha)	2,340	0.40	935	20
Small (1–2 ha)	975	1.40	1,365	30
Medium (over 2 ha)	585	3.90	2,300	50
Total	3,900	1.90	4,600	100

ha = hectare.

Source: Project Preparatory Technical Assistance 7954-IND Final Report (August 2013).

3. Present Situation (Without Project)

9. Paddy is the main crop for both the kharif (45% of farm holding) and rabi (40%) seasons (Table 2). Sugar (15%) and tree crops, mainly areca nut (35%), also occupy large areas. Other semidry crops (under 1%) and other tree crops (banana and coconut [5%]) cover small areas, but are not included as separate crops in the analysis. Overall cropping intensity is about 138%, and potential for increasing cropping intensity is low because of the large area of perennial crops. Yield rates are assumed to decline by 20% without the project because of restrictions in the available water supply.

4. Future Situation (With Project)

10. The CCA with the project remains at 4,600 ha, though a reduction in area is likely as the built-up area increases. Conservative adoption rates were used for the analysis. No benefits were assumed in project year 1, and full uptake of the new crop technologies is assumed to be completed in project year 5. The direct benefits of the subproject are derived by avoiding a decline in yields resulting from water shortages, and improved yields resulting from better irrigation and crop management. Farmers are expected to continue cultivating paddy as the major crop during the kharif and rabi seasons, taking up SRI, and expanding areca nut. Yield rates are assumed to increase with new technology by only 20% in a sigmoid pattern over 3 years.

Table 2: Project Cropping Patterns and Yields

Crops	Without Project Area (ha)	Without Project Percent of Area	With Project Area (ha)	With Project Percent of Area	Without Project Yield (kg/ha)	With Project Yield (kg/ha)
Command Area			4,600			
A. Kharif Season						
1. Paddy	1,400	30	450	10	5,450	7,000
2. SRI paddy	0	0	450	10	0	8,000
3. Other	350	8	350	8	5,500	6,600
B. Rabi Season						
1. Paddy	1,000	22	100	2	5,500	6,600

⁶ These are: (i) enriched soil with organic matter, (ii) alternate wetting and drying or intermittent irrigation, (iii) provision of soil nutrients, and (iv) weeding.

2. SRI paddy	0	0	400	9	0	7,000
3. Other rabi	750	16	750	16	5,500	6,600
C. Perennial Crops						
1. Sugarcane	550	12	550	12	85,000	100,000
2. Areca nut	2,300	50	2,800	61	15,000	18,000
Total Area (and CI)	6,350	138	5,850	127		

CI = cropping intensity, ha = hectare, kg = kilogram, SRI = system of rice intensification.

Note: With Project is in project year 25

Source: ADB estimates.

5. Production Levels and Output Marketing Constraints

11. The production of most crops will increase about 17%–43%, but paddy rice is replaced with perennial crops so production will decline. Scheme production is a tiny percentage of the total for Karnataka state except for areca nut, which reaches about 2%. No marketing issues are likely to develop.

Table 3: Production with and without Project (tons)

Crops	Without Project	With Project, Full Development	Increase (%)	Karnataka State Production (FY2006)	Subproject as % of Karnataka
Rice (paddy)	13,130	10,210	(25)	6,000,000	0
Sugarcane	46,750	55,000	17	19,650,000	0
Areca nut (dry nut)	3,500	5,000	43	215,000	2
Other (semidry crop)	3,850	4,620	17

... = data not available, () = negative.

Source: Directorate of Economics and Statistics. 2005–2006. *Report on Area, Production, Productivity and Prices of Agricultural Crops in Karnataka*. Bangalore.

6. Farm Financial Income

a. Marginal Farms

12. Retained farm income is expected to increase by 53% for marginal farm households (Table 4). This includes the value of family labor retained, as they would not need to hire labor. Income levels remain low, at about Rs30 per person per day, but the return to family labor is attractive. These increases are adequate to provide an incentive to participate in the subproject, but marginal farmers will need to find alternative employment. The household will consumer a high proportion, about 40%, of the paddy output. Cash incomes are likely to be low, and mainly used to finance bought crop inputs.

Table 4: Farm Income, with and without Project (Rs)

Without Project	Marginal	Small	Medium
Output value	66,624	268,481	742,319
Operating costs	28,534	115,418	323,846
Family labor	44	143	371
Hired labor	0	0	26
Retained income	38,090	153,063	418,473
Return per family labor day	866	1,070	1,128
With Project	Marginal	Small	Medium
Output value	85,570	334,128	925,520
Operating costs	27,625	119,036	336,929
Family labor	49	131	296
Hired labor	0	0	51
Retained income	57,945	215,092	588,591
Return per family labor day	1,183	1,642	1,988
Annual O&M cost	320	1,120	3,432
Percent increase output value	30	25	25
Percent increase retained income	53	41	41

O&M = operation and maintenance.

Note: Operating costs exclude family labor.

Source: Project Preparatory Technical Assistance 7954-IND Final Report (August 2013).

b. Small Farms

13. Retained farm income is expected to increase by 41% for small farm households (Table 4). This includes the value of family labor retained by the family, which would not need to hire labor. Production of paddy rice averages 1.2 kilograms per person per day, and there is substantial production of areca nut and sugar enabling it to be marketed. Sales should be adequate to finance crop inputs. Income levels with the project are about Rs133 per person per day, and return to family labor is attractive. These increases are adequate to provide an incentive to participate in the subproject and pay for O&M.

c. Medium Farms

14. Retained farm income is expected to increase by 41% for medium farm households (Table 4). This includes the value of family labor retained by the family, which would need to hire about 51 days of labor per year. Rice production is well above subsistence requirements. Income levels with the project are about Rs310 per person per day. These increases are adequate to provide an incentive to participate in the subproject and pay for O&M.

7. Capacity and Willingness to Pay for Operation and Maintenance

15. Annual O&M costs are estimated at Rs800 per ha per year. The incremental benefits from the increased crop production are considerably larger, so all farmers are able and likely to be willing to pay for O&M. Charges for O&M are under 1% of farm income and other crop production costs. Marginal farmers without alternative incomes may be unwilling to pay. State agencies will continue to operate major infrastructure and the main irrigation conveyance and distribution systems. The state budget will continue to be allocated and KNNL will perform maintenance for the main system.

E. Economic Analysis

1. Methodology and Assumptions

16. The economic internal rate of return (EIRR) and benefit–cost ratio are estimated over 25 years. Sensitivity analysis was undertaken for increased costs, and reduced or delayed benefits. The social discount rate is 12%.

17. Land below Km45 of the Gondri right bank canal is supplied by seepage flows, which will cease as a result of rehabilitation of the Bhadra irrigation scheme. This will affect 1,762 ha (38%) of the Gondri scheme, which is receiving this supplemental seepage flow. Farmers might increase pumping, but it is more likely that perennial cropping would cease. The analysis assumes that 20% of production for Gondri would be lost without the project; avoiding this through canal rehabilitation is claimed as a direct benefit. The project will promote the use of water saving crops. Without the project, it is assumed that the area of areca nut would increase from 50% to 70% of the CCA, and rice production would be restricted to subsistence requirements.

18. The detailed project report for Gondri (prepared by KNNL) indicates that modernization of the canal system will release 0.5 MCMF (thousand million cubic feet) or 14 million cubic meters

(m³) of water for new irrigation in the Upper Bhadra schemes. The value of this water has been estimated at Rs21 per cubic meter using crop benefits at full development, and is added to the with scheme benefits, net of water delivery and distribution cost, and current (2013) crop production value. The net value added is taken as 25%. Canal reconstruction earthworks costs are 45% of the concrete lining option. Canal lining costs of Rs386 million are removed from project costs where appropriate. The various scenarios used in the economic analysis are below.

19. The scenarios tested are summarized in Table 5.

Table 5: Scenarios Modeled

Scenario	Characteristics
Current (2013)	Current cropping pattern, areca nut increases 20% replacing paddy
Without project	No increase in base yields, yield increments resulting from project (+20%) Bottom 38% of Gondi loses supplemental irrigation supply from Bhadra scheme, production falls by 20% 400 ha areca nut lost, rest uses pumped river water
With project A1a (lined canal)	Canal lining 100%, water supplied along length of canal, no production loss Limited irrigation supply as supplemental flow from Bhadra scheme Productivity increases (20%), reduced areca nut area expansion
With project A1b (lined canal)	Canal lining selective, water supplied along length of canal Productivity increases (20%), reduced areca nut area expansion
With project A2	Add net value 0.5 MMCF (14 million m ³) water transferred to Upper Bhadra scheme

ha = hectare, m³ = cubic meter.

Source: Project Preparatory Technical Assistance 7954-IND Final Report (August 2013).

a. Economic Prices, Taxes and Duties, Inflation, and Exchange Rates

20. Economic price estimates, current levels of duty, local taxes, and conversion factors are detailed in the Feasibility Studies Supplementary Report, Financial and Economic Analysis Markets and Prices. A summary of the financial and economic prices and conversion factors is in Supplementary Appendix 1. Economic prices of traded commodities (paddy conversion factor 1.0, oil crops conversion factor 1.7, and fertilizers conversion factor 1.4–3.0) are based on 2012 farm gate values at border parity. Conversion factors are estimated for crop chemicals (0.8) and mechanized operations (1.2, because of the fuel subsidy). Unskilled and agricultural labor is adjusted by a shadow wage rate of 0.9, and skilled labor by a conversion factor of 1.0. A construction conversion factor (0.8) was based on the weighted conversion factor for materials, fuel and equipment, labor, and overheads. Other costs use a standard conversion factor of 0.9. Constant 2012 prices were assumed so inflation was not included. The exchange rate was \$1 = Rs55.

b. Excluded Costs

21. There were no excluded costs for the subproject, but only a proportion of the project management costs (10% of the total scheme costs) were attributed to the scheme overheads. The majority of project management costs are for state level institutional development.

c. Project Cost

22. Financial project costs, adjusted by the conversion factor in para. 20, give the assumed cost of Rs1,213 million. Construction contracts will include provision for continued water supplies for perennial crops, so cropped areas are assumed to be maintained during construction.

d. Project Benefits

23. Crop production benefits result from increased yields from irrigation and improved agricultural practices, and a small shift to higher value crops. Loss of water to the tail reaches of Gondi, without the project, is modeled by reducing the without-project outputs and production costs by 20%. Additional pumping costs for remaining perennial crops, if any, are ignored, so the reduction in value is conservative. Use of water saved by the scheme modernization is modeled assuming a water value for new irrigation. Institutional strengthening of the Water Resources Department, other concerned agencies, and farmers, including participatory irrigation management, will result in improved water management. Expected yield reductions resulting from declining water availability will be avoided. Agricultural support programs, which include farmer training and farm demonstrations, are included in the economic model as assumed yield and production increases. Economic benefits are calculated from the incremental value of crop production generated by the subproject, net of production cost at economic input and output prices. Livestock benefits are included by valuing fodder and crop residues. Project benefits excluded from the analysis include small fishery developments, and health.

2. Results of the Economic Analysis

24. The economic returns are shown in Table 6 and detailed EIRR tables are in Supplementary Appendix 1. The Gondi scheme, with selective channel lining, is extremely robust with an EIRR of 17%. Adding the value of water saved and diverted improves returns considerably to an EIRR of 22%. It is not certain the water savings proposed can be achieved, as they are a considerable proportion of the total water supply to the scheme, so a conservative approach is adopted by selecting the subproject with selective lining as the base case.

Table 6: Economic Returns to Gondi Scheme

Scenario	Saved Water Net Return (%)	EIRR (%)	NPV (Rs million)	B-C ratio
A1a: Gondi scheme, 100% lining		9	(138)	0.8
A1b: Gondi scheme, water supplied to tail reaches with selective lining		17	274	1.2
A2: Add value of water saved and provided to Upper Bhadra	25	22	631	1.4

() = negative, B-C = benefit-cost, EIRR = economic internal rate of return, NPV = net present value.

Source: Project Preparatory Technical Assistance 7954-IND Final Report (August 2013).

a. Sensitivity Analysis

25. Parameters tested were (i) increased investment costs, (ii) delay in achieving full benefits, (iii) shortened subproject life, (iv) reduced benefits (crop output or price), and (v) increased crop production costs.

Table 7: Sensitivity Analysis

Change	EIRR (%)	Switching Value (%)	Sensitivity Indicator
Base water supplied to tail reaches with selective lining	17		
Construction and CAD costs increased by 10%	15	35	1.0
Project benefits delayed by 2 years	11		
Project life reduced by 5 years	17		
Incremental benefits, yields and price reduced by 10%	14	15	1.9
Crop production costs increased by 10%	16	40	0.8

CAD = command area development, EIRR = economic internal rate of return.

Source: Project Preparatory Technical Assistance 7954-IND Final Report (August 2013).

26. The sensitivity tests and risk analysis confirm that project 1 is robust. The subproject was not very sensitive to construction cost increases, but was sensitive to construction delays. Reducing the production value by 10% reduces the EIRR to 14%, with a switching value of 15% reduction, so the project is slightly sensitive to prices and yield rates. Increased production costs are less sensitive, as net returns are generally high.

F. Benefit Distribution and Poverty Impact Analysis

27. Subproject level financial incomes with and without the project, at full development, provide the incremental output and costs to subproject farmers (Table 8). These benefits and costs are distributed in proportion to the total farm area of large, small, and marginal farmers (Table 9). The value of contract planting and harvesting are included in hired labor, which does not change greatly as a result of the project, but would reduce significantly without the project. Production, operating costs, and labor are assumed to be reduced by 20% in the without-project scenario.

Table 8: Incremental Financial Farm Incomes (Rs million)

Benefits and Costs	Financial Farm Incomes		
	Without Project	With Project	Incremental Income
Project Output	802	1,088	286
Production Costs (excluding labor)	280	327	(47)
Total Farm Labor Value	122	154	(32)
Benefits			207

() = negative.

Notes:

1. Assuming a 20% production reduction without the project.
2. Net benefits include the value of household labor, retained by the household.

Source: PPTA socioeconomic baseline data, 2012.

Table 9: Distribution of Incremental Incomes (Rs million)

Benefits and Costs	Distribution of Incremental Income				Total
	Medium Farmers	Small Farmers	Marginal Farmers	Labor	
Share of benefits (% of area)	50	30	20	0	100
Project output	143	86	57		
Production costs (excluding labor)	(24)	(14)	(9)		
Total farm labor value	(16)	(10)	(6)		
Hired labor (%)	50	20	0		
Hired labor cost	(8)	(2)	0	10	
Benefits	95	60	42	10	207
Household labor value	8	8	6		
Proportion of poor (%)	11	11	60	100	
Net benefits and costs to the poor	11	7	29	10	57
Proportion of benefits to poor households					28%

() = negative.

Source: Project Preparatory Technical Assistance 7954-IND Final Report (August 2013).

28. The total farm financial labor values (total labor days used, at Rs210 per day) are shown in Table 8, but are retained by the farm family, except for the estimated labor hiring. It is assumed that medium farmers hire 50% of the incremental labor requirement, small farmers 20%, and marginal farmers do not hire. The net labor hired is removed from farmer benefits and added to the benefit of labor. The benefits flowing to poor households are based on the proportion of poor in each category, using the percentage of below poverty line households found in the household survey. It is assumed all labor is poor.