ECONOMIC AND FINANCIAL ANALYSIS

A.   Introduction

1.   The four northeastern provinces of Bac Kan, Cao Bang, Ha Giang, and Lang Son consist largely of ethnic minorities, who are among the poorest and most remote people in Viet Nam. The 5-year sector project will develop infrastructure to support inter-provincial economic connectivity and improve rural living standards. The economic and financial analysis covers three project outputs: (i) road network connectivity improved through upgrading 265 kilometers (km) of provincial and district roads, investing $126.4 million; (ii) rural water supply improved through the development of 10 rural domestic water supply (RDWS) schemes, investing $20.6 million; and (iii) agricultural and rural value chain (ARVC) infrastructure in Lang Son province improved, investing $15.6 million. The analysis focuses more attention on output 1 given its 64% share in the overall investment. The subprojects of each output have different economic lives and yield different benefits, which will be documented accordingly in subsequent sections.

2.   The economic analysis was based on the Asian Development Bank (ADB) Guidelines for Economic Analysis of Projects.[1] The following assumptions were used:
  (i)   All items are in 2017 constant price.
  (ii)   A general rate of value-added tax is 10% in Viet Nam and an additional 5% of tariffs is deducted from tradable components.
  (iii)   The analysis uses world price (dollars) numeraire.
  (iv)   The exchange rate is D22,500 = $1.
  (v)   A shadow wage factor (SWF) of 1.0 is applied to the salary of the water plant employees, who are mostly skilled or semi-skilled. An SWF of 0.9 is applied to the time value of project beneficiaries, who are mostly farmers and unskilled workers.
  (vi)   A standard conversion factor (SCF) of 0.95 is applied to nontradable items.[2]
  (vii)   The social cost of capital is 9%.

B.   Output 1: Road Network Connectivity in the Four Northeastern Provinces Improved

3.   Four representative subproject (RSP) feasibility studies were carried out for provincial or district roads in each of the provinces. These investments would not take place without external financing. Operation and maintenance (O&M) of the RSP roads will be financed by the provincial governments. In the without-project scenario, the roads would only receive a fraction of the budget required for full maintenance: 22.5% in Bac Kan, 50.0% in Lang Son, 75.0% in Ha Giang, and 50.0% in Cao Bang. In the with-project scenario, the roads will be upgraded with a double bituminous surface treatment, which is more cost efficient than the alternatives considered.

4.   Traffic forecasts were prepared using October 2016 traffic counts, expected growth in provincial gross domestic product (GDP), income elasticity of demand, and analysis of regional trade, tourism and other travel patterns. GDP of the four provinces grew at rates of 3.8%–6.5% in 2015, are assumed grow at 5.0%–7.0% until 2025, slow to 4.0%–6.0% until 2035, and stabilize at 2.5%–3.5% thereafter. Income elasticities of 0.86 to 0.90 were applied to provincial GDP growth rates to derive estimated average traffic growth of 4.7%–6.5% in the same period.[3]

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[1]   ADB. 2017. *Guidelines for Economic Analysis of Projects*. Manila.
[2]   The SCF of 0.95 was confirmed as current for Viet Nam - country profile of the World Trade Organization website.
[3]   J. Dargay, P. Goodwin, and M. Hanly. 2004. Elasticity of Road Traffic and Fuel Consumption with Respect to Price and Income: a Review. *Transport Reviews.* 24 (3).

5.   Three traffic types were considered: (i) local existing, normal traffic that occurs with or without the project, attributable to income growth; (ii) local generated traffic that materializes in response to reduced travel costs associated with improved road conditions; (iii) where applicable, diverted traffic that from outside the subproject area but is rerouted to the subproject roads to take advantage of the shorter travel distance. Table 1 summarizes the traffic types, the sources of traffic, determinants, and the subprojects that were identified with these traffic types.

Table 1: Traffic Type

Traffic Type	Source	Determinant	Incremental	Subprojects
Normal	Local users	Income growth	No	Ha Giang, Cao Bang, Bac Kan, Lang Son
Generated	Local users	Reduced road user costs	Yes	Ha Giang, Cao Bang, Bac Kan, Lang Son
Diverted	Outside users	Reduced road user costs	No	Bac Kan, Lang Son

Source: Asian Development Bank estimates.

6.   Each traffic type consists of different vehicle types: (i) passenger vehicles, including motorcycles, cars, pickups, and buses (small, medium, heavy); and (ii) freight vehicles, including trucks classified as small (less than 5 tons), medium (with two axles, between 5 and 10 tons), and heavy and tractor trailers (with three or more axles and more than 10 tons).

7.   Normal traffic depends on income growth. For analytical purposes, generated traffic is taken to be percentages of normal traffic, as presented in Table 2. For the Ha Giang subproject, the traffic count and composition of freight vehicles is determined by the nearby Binh Vang economic zone. The 2016 traffic count for the Ha Giang subproject recorded many light and medium trucks that are smaller and better able to cope with difficult road conditions. In the with-project scenario, the freight traffic composition is expected to shift to heavier trucks.

Table 2: Generated Traffic as Percentage of Normal Traffic

Province	Passenger traffic	Freight traffic (%)	
		Small and Medium Trucks	Heavy Trucks
Ha Giang	35		
Cao Bang	50	35	25
Bac Kan	50	40	20
Lang Son	30	20	20

Source: Asian Development Bank estimates.

8.   In addition to normal and generated traffic, the Bac Kan and Lang Son subproject roads will carry diverted traffic. Householders in the western Cao Bang districts make regular trips from Hung Dao to Hanoi. The subproject will stimulate passenger transport operators to offer new service routes, diverting a portion (estimated at 50%) of the existing passenger traffic from western Cao Bang on the Hung Dao–Cao Bang City–Hanoi route to the new Hung Dao–Bac Kan City–Hanoi route. The one-way reduced travel distance of 110 km results in time and cost savings for passengers. For the Lang Son subproject, 30% of the existing visitors or tourists to Bac Kan are expected to be diverted to this route because of the shorter distance (reduced by 150 km one way). In addition, 17,000 tons of produce from Na Ri district in Bac Kan are exported to the People's Republic of China via Cao Bang each year. The Lang Son subproject will offer a shorter one-way route for these exports (220 km). Table 3 presents the sum of normal and generated traffic count by vehicle type in the with-project scenario.

Table 3: With-Project Scenario Traffic Forecast (Including Normal and Generated Traffic)

	Passenger Traffic (daily vehicles)						Freight Traffic (daily vehicles)			
Year	Motor-cycle	Personal Car	Pickup	Small Bus	Medium Bus	Heavy Bus	Small Truck	Medium Truck	Heavy Truck	Truck and Trailer
Ha Giang traffic count[a]										
2016[b]	1,242.0	55.0	0.0	1.0	0.0	0.0	75.2	22.8	3.7	1.3
2020	1,870.5	88.4	0.0	1.7	0.0	0.0	6.5	1.9	9.0	15.0
2030	2,201.7	148.1	0.0	2.9	0.0	0.0	10.6	2.3	14.6	24.4
2040	2,226.1	212.2	0.0	4.0	0.0	0.0	13.1	3.8	18.2	30.3
Cao Bang traffic growth count										
2016[b]	147.2	29.0	0.0	5.1	2.4	0.0	26.6	38.5	33.9	20.2
2020	238.0	49.0	0.0	8.9	4.2	0.0	41.7	60.3	49.2	29.3
2030	271.5	74.7	0.0	13.8	6.5	0.0	65.0	94.0	76.7	45.7
2040	274.2	105.9	0.0	19.2	9.0	0.0	90.0	130.2	106.2	63.3
Bac Kan traffic growth count										
2016[b]	362.5	24.0	0.0	0.0	0.0	0.0	24.7	0.7	0.0	0.0
2020	525.7	37.1	0.0	0.0	0.0	0.0	42.9	1.1	0.0	0.0
2030	618.8	62.2	0.0	0.0	0.0	0.0	74.0	1.9	0.0	0.0
2040	625.6	89.1	0.0	0.0	0.0	0.0	103.6	2.7	0.0	0.0
Lang Son traffic growth count										
2016[b]	143.1	17.5	0.0	1.7	0.0	0.0	59.0	0.0	0.0	0.0
2020	211.2	27.8	0.0	2.8	0.0	0.0	113.6	0.0	0.0	0.0
2030	249.4	47.0	0.0	4.8	0.0	0.0	197.7	0.0	0.0	0.0
2040	252.1	67.2	0.0	6.7	0.0	0.0	276.3	0.0	0.0	0.0

[a] Including generated traffic.
[b] Figures for 2016 represent traffic counts taken on the subproject roads in October 2016, except for motorcycles. Adjusting for the use of motorcycles for local transport, only 50% of the count is included in the 2016 figure.
Source: Asian Development Bank estimates.

9. Project costs consist of economic costs of road construction, routine and periodic maintenance, consulting services, and 16% of physical contingencies. All RSP roads have an estimated economic life of 15 years. With routine and periodic maintenance, the economic life can be extended to at least 21 years. The analytical time frame used is 24 years, inclusive of 3 years of construction. Annual depreciation is computed to derive the residual value of each road at the end of the analytical period. The financial costs of the RSP roads are presented in Table 4.

Table 4: Subproject Road Investment and Annual Maintenance Cost (Inclusive of Taxes)

Province	Investment ($ million)	Taxes (%)	Tradable (%)	Non-tradable (%)	Economic Life (years)	Annual Maintenance ($'000)	Periodic Maintenance in 2030 ($'000)
Ha Giang	13.38	15	60	40	15	63.5	127.0
Cao Bang	15.61	15	60	40	15	57.3	114.5
Bac Kan	11.97	15	60	40	15	68.8	137.5
Lang Son	11.05	15	60	40	15	56.0	112.0

Source: Asian Development Bank estimates.

10. Project benefits are in the reduction in road user costs. The total road user cost consists of vehicle operating cost and time cost, which vary by vehicle types and road conditions.[4] The computation of the vehicle operating cost and time cost are documented in the supplementary documents to the report and recommendation to the President.[5] The costs were first derived in

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[4] During project preparation, other sources of benefits were considered, including reduced carbon emission and avoided accidents. The analysis weighted the reduction in carbon emission and accident incidence due to reduced travel distance against a potential increase due to increase speed and generated traffic brought about by improved road conditions. However, these potential benefits streams are not captured in this report.
[5] Economic and Financial Analysis Roads [Detailed]; Economic and Financial Analysis Water [Detailed] (accessible from the list of supplementary documents in Appendix 2).

local currency and then converted to economic value in world price numeraire using appropriate conversion factors. The with-project costs are less than the without-project costs because of improved road conditions. Reductions in costs are equivalent to increasing the consumer surplus of road users.

11.   Road users under the normal traffic category are already traveling on the RSP roads. Since normal traffic is nonincremental, all the cost savings are taken as the economic benefits. Similarly, diverted traffic is nonincremental and therefore all the cost savings are taken to be the benefits. Without the project, the travel cost is too high for some potential road users. These potential road users will start traveling when road conditions improve and travel costs decrease, leading to additional generated traffic, which is considered incremental. While road users in this category still gain from road use, the magnitude of the gain will be less than the existing road users of the normal category, who attach a higher value to road use as they make trips despite the current road conditions. In the analysis, 50% of the cost reduction is taken to be the economic benefit for generated traffic. Table 5 summarizes the benefit streams for each traffic type.

Table 5: Traffic Type and Associated Benefits

Traffic type	Benefits	Subprojects
Normal	VOC and TC savings on subproject roads	HG, CB, BK, LS
Generated	50% of normal traffic VOC/TC savings	HG, CB, BK, LS
Diverted	VOC and TC savings from reduced travel distance	BK passenger traffic BK passenger and freight traffic

CB = Cao Bang, BK = Bac Kan, HG = Ha Giang, LS = Lang Son, TC = time cost, VOC = vehicle operating costs.
Source: Asian Development Bank estimates.

12.   Table 6 presents the economic internal rates of return (EIRRs) and the sensitivity analysis of each road subproject. The results indicate that the economic viability is robust against risks.

Table 6: Economic Rates of Return and Sensitivity Analysis Results

		EIRR (%)			
Subproject		+10% investment cost	+10% maintenance cost	−10% traffic forecast	−10% VOC and TC savings
Ha Giang	9.7	8.7	9.6	9.9	9.0
Cao Bang	10.2	9.1	10.1	10.2	9.0
Bac Kan	10.1	9.1	9.9	9.9	8.8
Lang Son	10.2	9.0	10.0	10.2	8.7

EIRR = economic internal rate of return, TC = time cost, VOC = vehicle operating costs.
[a] A switching value of a variable is an adverse percentage change relative to the variable base value, or a combination of changes relative to a selection of variable base values, that causes the subproject benchmark net present value to fall to zero.
Source: Asian Development Bank estimates.

C.   Output 2: Rural Water Supply Improved

13.   Feasibility studies for three RSPs were prepared for output 2—RDWS schemes in Bac Kan, Cao Bang, and Ha Giang provinces. For analytical purposes, the construction of the water plant and the main water distribution network will start simultaneously in 2019 and be completed within 1 year. Table 6 presents the estimated service provision of the three RSPs by 2030. At construction completion (2020), the RDWS plants will provide service to 70% of the total number of customers at full capacity. Over time, new customers will subscribe and defray the connection costs of about D2 million per connection. By 2030, the number of paying customers will reach 2,157 in Ha Giang, 2,453 in Cao Bang, and 1,126 in Bac Kan. The total quantity of water supplied

to these customers is 1,119 cubic meters (m^3) per day in Ha Giang, 1,235m^3/day in Cao Bang, and 757 m^3/day in Bac Kan. Lastly, the proposed tariffs are set at a rate that is affordable for households. At the forecasted consumption level, expenditure on water is less than 5.0% of average household income.

14.　It is expected that nonrevenue water supplied is about 15% of revenue water supplied. These nonpaying users, mostly private households, will not contribute to the subprojects' financial performance but benefits of water consumption are included in the economic analysis.

Table 7: Estimated Subproject Water Service Provision by 2030

Item	Ha Giang	Cao Bang	Bac Kan
Population	8,263	9,677	4,791
Connection			
Households	2,046	2,403	1,081
Government agencies	61	40	30
Businesses establishments	50	10	15
Total connections	2,157	2,453	1,126
Water supply			
Maximum capacity (m^3/day)	2,186	2,124	1,340
Water sales (m^3/day)	1,199	1,235	757
Nonrevenue water	180	185	114
(m^3/day, 15% of revenue water)			
Proposed water tariff at 2020 (D/m^3)	8,050	7,000	7,150
Periodic increase (once every 3 years)	15.0%	15.0%	15.0%
Water tariff as % of household income	2.2%	3.4%	4.6%

m^3 = cubic meter.
Source: Asian Development Bank estimates.

15.　Project costs consist of economic costs of water plant construction, distribution network construction, equipment costs, operating costs, periodic maintenance, and 10% for physical contingencies. With periodic maintenance, the economic life can be extended to at least 24 years. The analytical time frame is 25 years, inclusive of 1 year of construction. Annual depreciation is computed to derive the residual value of water plant at the end of the analytical period. The financial investment costs of the subprojects are presented in Table 8. In the economic analysis, the financial costs are converted to their economic values by first netting out taxes, and then applying the SCF to the nontradable components.

Table 8: Rural and District Water Supply Subproject Investment and Annual Maintenance Cost (Inclusive of Taxes)

Subproject	Investment ($ '000)	Taxes (%)	Tradable (%)	Nontradable (%)	Periodic Maintenance[a] ($ '000)
Ha Giang	2,327	10	80	20	46.5
Cao Bang	2,305	10	80	20	46.1
Bac Kan	1,145	10	80	20	22.9

[a] 2% of investment cost, once every 5 years
Source: Asian Development Bank estimates.

16.　Operating costs for the new water plant is based on those of an existing water plant in Vinh Quang, Ha Giang (Table 9). The actual amount of overhead costs are adjusted by the size of the new plants relative to that of the Vinh Quang plant. The new plants are expected to require less electricity as water delivery will rely on gravity flow, but will require more chemical treatment. The variable costs are computed by multiplying the (adjusted) variable cost of the Vinh Quang

plant with the forecasted sales quantity. In the economic analysis, these financial values are converted to economic values using appropriate conversion factors.

Table 9: Operating Cost for an Existing Water Plant in Vinh Quang, Ha Giang

Item	Amount (D million)	Composition Overhead (%)	Composition Variable (%)	Overhead (D million)	Variable (D million)	Variable (D/m³)
Costs						
Electricity	307.6	0	100	0.0	307.6	2,129.6
Chemicals/materials	156.4	0	100	0.0	156.4	1,082.8
Wages	315.3	50	50	157.7	157.7	1,091.4
On costs	118.9	50	50	59.4	59.4	411.4
Office costs	33.8	100	0	33.8	0.0	0.0
Tools office/plant	22.2	55	45	12.2	10.0	69.7
Repairs	21.9	0	100	0.0	21.9	151.8
Other operating	13.4	0	100	0.0	13.4	92.5
Total operating costs	**989.5**			**263.1**	**726.4**	**5,029**
Tax	**108.3**	**27**	**73**	**29.2**	**79.0**	**550.4**

m^3 = cubic meter.
Source: Asian Development Bank estimates.

17.   Project benefits are measured by the willingness to pay (WTP) of different user groups for all-season availability of potable water, the time cost savings, and health benefits for connected households. A general estimate on households' WTP was undertaken during the socio-economic surveys, which suggested that households are willing to pay at least 5% more than the proposed tariffs, which translates to a WTP of 105% of proposed tariffs. The 5% premium is validated during focus group discussions. Since the tariffs are set to ensure affordability for households, the WTP for other water user groups, i.e., business establishments and government agencies, must be significantly greater than 105% of the proposed tariffs. In the economic analysis, the WTP is taken to be 110% of the tariffs.

18.   Health benefits are estimated based on the reported incidence of waterborne disease in the surveys, the expected time off work, and cost of medicine. Incidence of waterborne disease include diarrhea and sore eyes, and varies by subproject. On average, the annual time lost due to diarrhea is 2 days, including time off from paid work, performing household duties, schooling, and visits to health clinics. The time lost due to eye sores is 7 days. The average cost of medication for each incident of disease D150,000. It is expected that in the with-project scenario the reported incidence of disease will be reduced by 75% because of availability of treated water. The average time households spend on water collection also varies by subproject. The value of time is estimated at 60% of the daily rural wage, which is D150,000.

19.   The various benefit streams were first computed in local currency and in financial values. To derive the economic values, taxes were deducted, followed by adjustment by the SWF (for time cost savings) and SCF, and finally converted to dollars, the world price numeraire at the exchange rate of D22,500 = $1.

20.   Table 10 presents the FIRRs and EIRRs based on the aforementioned assumptions. The FIRRs range from 2.5% to 3.2%, slightly higher than the weighted average cost of capital (2.1%–2.4%). The subproject EIRRs range from 9.2% to 9.4%. The EIRR estimates are conservative as some benefits (such as savings in coping costs) were identified but not quantified due to lack of data.

Table 10: Financial Internal Rates of Return, Economic Internal Rates of Return, and Sensitivity Analysis Results

		FIRR or EIRR (%)			
Subproject		+10% Investment Cost	+10% Operating Cost	−10% Project Benefits	−10% New Connections
FIRR					
Ha Giang	3.2	2.7	2.9	3.2	3.2
Cao Bang	2.5	2.0	2.0	2.5	2.3
Bac Kan	2.5	2.0	1.9	2.5	2.4
EIRR					
Ha Giang	9.4	8.5	9.1	9.1	9.2
Cao Bang	9.2	8.3	8.8	8.8	9.0
Bac Kan	9.3	8.4	8.8	8.9	9.1

EIRR = economic internal rate of return, FIRR = financial rate of return.
Source: Asian Development Bank estimates.

D.   Output 3: ARVC Infrastructure in Lang Son Province Improved

21.   Output 3 includes two ARVC RSP: star anise, and safe vegetable cultivation. The star anise value chain subproject will work with a cooperative and several associated farmer marketing groups (FMG) whose members own 400 hectares (ha) of star anise in Van Quan district, Lang Son province. The project will support the cooperative to establish intermediate-scale processing facilities to support efficient drying and consequent quality improvement.

22.   The current average yield is 2 tons/ha. With the project, the yield will increase by 10%. Prices have been high over recent years, partly because star anise is a raw material in the pharmaceutical production of Tamiflu (for bird flu control). A leading Vietnamese processor of star anise has expressed strong interest in developing the value chain for the product. Price is projected to stabilize at D15,000 per kilogram (kg). With the project, improved quality is expected to generate an average price of D18,000/kg. The investment cost is $380,000.

23.   A new plantation of star anise produces little until 10 years after planting. Based on a year-10 yield of 2.0 tons/ha without the project and 2.2 tons/ha with the project, the new plantations without the project are budgeted to produce financial returns of 11%, and with the project 18%. If no new plantations are added, the impact on FIRR would be small. With the input and output parameters assumed, processing margins are quite tight and the direct return on processing plant investment low. However, as an integrated venture, with the processing plant owned by the cooperative, the integrated venture is feasible and generates an overall FIRR estimated at 13.6%.

24.   In the economic analysis, the investment cost is net of taxes, which are about 10%, and farm labor is shadow priced. There are no export taxes on star anise. All cost items and revenue are adjusted by appropriate conversion factors. Based on these assumptions, the EIRR at the farm level is 15.4%. The major financial risk faced by the star anise value chain is the potential for prices to decline further than forecasted. However, farm costs are only budgeted at 44% of sales with the project, and thus the crop should remain profitable under this circumstance.

25.   Output 3 will also support FMGs to cultivate safe vegetables in Tu Xuyen commune, Van Quan district, Lang Son province. At present, the commune predominantly plants paddy in spring and summer, with many farmers also planting a winter horticultural crop. With the project, the FMGs will grow two vegetable crops in winter and spring and a third rice crop over the summer

wet season, when the land is too wet for vegetable cultivation. A FMG consists of about 10 farmers, who own 1.2 ha of area for intensive vegetable production. Per-hectare crop budgets were estimated for a range of rice and vegetable crops both without and with the project.

Table 11: Paddy and Vegetable Gross Margins Without and With the Project

Item	Revenue (D million/ha)	Total Costs[a] (D million/ha)	Gross Margin (D million/ha)	Gross Margin ($/ha)
Without project				
Spring paddy	28.1	27.3	0.8	35
Summer paddy	20.4	20.8	(0.4)	(16)
Winter vegetable	25.0	15.4	9.6	429
With project				
Summer paddy	22.2	20.8	1.4	64
Vegetable crops				
1. Tomatoes	221.6	85.1	136.5	6,106
2. Waky pumpkin	177.3	77.8	99.4	4,450
3. Potatoes	66.5	56.1	10.4	464
4. Cabbage	121.9	58.9	63.0	2,819
5. Kohlrabi	177.3	74.1	103.2	4,618
6. Carrot	150.0	74.8	75.2	3,366
7. Water melon	110.8	25.6	85.2	3,813
8. Chilies	174.5	77.9	96.6	4,321
9. Cucumber	166.2	86.1	80.1	3,585
10. Green bean	165.0	71.8	93.2	4,171
Average	**153.1**	**68.8**	**84.3**	**3,771**

[a] Inclusive of imputed labor cost of D150,000 per day.
Source: Farmer interviews, 2016.

26. It is assumed that the without-project cropping pattern for the spring, summer, and winter seasons is rice–rice–vegetable, generating a net income of D10 million/ha ($444/ha), after netting imputed labor cost at D150,000 per day. The with-project crop pattern would switch to tomato–paddy–cabbage with a net income of D209 million/ha ($9,288/ha). Profitability will gradually increase through the initial years and reach the projected level, likely by year 4.

27. FMGs will receive an investment package to help it set up a vegetable production enterprise, to a possible maximum of D450 million/ha ($20,000/ha). The package may cover internal feeder road, irrigation, drainage, leveling, shade houses, and processing slabs. In the case of the pilot Tu Xuyen group, the total cost of the package is estimated at D657 million ($25,400), plus D89 million ($3,955) to cover working capital.

28. Following development in 2018, a near break-even outcome is expected in 2019, with improving performance to year 4. With tripling the cropping on 1.2 ha, net income is estimated at D251,000 in that year. Incremental gross margin is D223 million ($9,800), generating an FIRR of 23.5% over 20 years. The incremental income is D199 million ($8,844/ha), generating an FIRR of 23.5% over 20 years.

29. In the economic analysis, all cost items are converted to their economic prices using appropriate conversion factors. Paddy price is border priced, leading to a reduction of about 10% in economic value. Farm labor inputs are shadow priced at 0.9 of the rural wage. The situation with fertilizers is mixed—single superphosphate is manufactured locally, while urea and potash are imported. Overall, border price is estimated to be 10% below on-farm cost. Investment costs are reduced by 10%, reflecting removal of taxes. The EIRR is estimated to be 27.9%.