

Detailed Economic and Financial Analysis

June 2018

Lao PDR: Climate-Friendly Agribusiness Value
Chains Sector Project

I. INTRODUCTION

1. The Asian Development Bank (ADB) approved a project preparatory technical assistance for Climate-Friendly Agribusiness Value Chains Sector Project, with funding support from Japan's Asia Clean Energy Fund and the Canadian Climate Change Fund for the Private Sector in Asia. The project is a regional initiative covering Cambodia, Lao People's Democratic Republic (Lao PDR), and Myanmar and will invest in pro-poor, inclusive and climate-resilient agricultural value chains in Cambodia, Lao PDR, and Myanmar. The proposed project will enhance rural household incomes and agricultural competitiveness by providing improved critical production and post-harvest infrastructure, reducing energy costs by promoting bio-energy use and sustainable biomass management and offering targeted agribusiness policy and capacity support services.

A. Rationale

2. **Sector performance.** Lao PDR ranked 141 out of 181 countries in the human development index. Macroeconomic and political stability has enabled the country to achieve moderate economic growth, with gross domestic product (GDP) per capita reaching an estimated \$1,912 in 2015 from \$1,296 in 2011. The GDP growth rate at constant prices has declined, however, from 8% in 2011 to 6.7% in 2015. Likewise, growth in the agricultural sector declined from 2.8% in 2011 to 2.0% in 2015. The contribution of the agriculture and natural resources sector to the economy has declined from 32.7% of GDP in 2010 to 27.1% of GDP in 2015. Although the contribution of agriculture to GDP is declining, the sector remains an important part of the economy, with around 65% of the working population employed in the sector. Nearly 80% of rural population is reliant on agriculture. Low growth in the agriculture sector has led to low levels of household incomes in rural areas. The government aims to increase the agricultural growth rate to 3.4% per annum by 2020.

3. **Binding constraints.** The sector faces a range of physical, economic, and capacity constraints, and is vulnerable to shocks from farm produce price fluctuations and impacts of climate change. Infrastructure and capacity constraints, including inadequate supply of inputs, production technologies and access to affordable credit, remain key barriers for promotion of agribusiness. An aging and declining labor force due to migration of youth to urban areas exacerbates the problem. Between 2005 and 2015, the rural population has declined from 72.8% to 67.1% of the total population. Therefore, creation of employment opportunities in rural areas through promotion of climate-friendly agribusinesses is critical to sustain the sector growth.

4. A poor enabling policy environment characterized by onerous registration requirements and conflicting regulations is another major barrier. A low level of private sector participation results in low investment at farm level in new and innovative technologies such as mechanization. Lack of adequate knowledge of value addition and marketing, and underdeveloped marketing systems also contribute to limited competitiveness of agricultural value chains. The unfavorable business environment thus leaves Lao PDR with underdeveloped value chains beyond the farm level, leaving farmers with fewer market options, and the economy with limited capacity for domestic transformation and value addition of the primary commodities that it produces.

5. The adverse impacts of climate change such as droughts and floods are already evident. Climate projections suggest that daily maximum temperatures may increase by 2°C to 3°C by 2050, with the highest increases anticipated in the south of the country, thereby exacerbating the severity of droughts.¹ Likewise, rainfall is projected to increase by 10%-30% during the rainy

¹ Mekong Adaptation and Resilience to Climate Change Project Study. 2015. *Lao PDR Climate Change Vulnerability*

season in the eastern and southern provinces of the country, thereby increasing flooding. The limitation of existing or nonexistence of adaptation measures will increase vulnerability of rural livelihoods and lead to food insecurity. Therefore, when considering diversification and commercialization of agriculture, suitable climate smart agriculture (CSA) technologies must be identified, tested, and disseminated to farmers.²

6. **Opportunities.** Investing in climate-friendly agribusiness value chain infrastructure coupled with targeted capacity strengthening and policy support is vital to address the above constraints. For example, intensive production and commercialization of high quality rice and organic vegetables, facilitated by local biofertilizer production and clean agricultural technologies, can increase rural household incomes, cut imports and save foreign exchange. Likewise, opportunities exist for developing domestic and export market-oriented agribusinesses and attracting the private sector investment in areas such as upgrading infrastructure for storage, processing and value addition, biofertilizer production, and risk sharing instruments such as crop insurance. The demand for a wider range of safe and nutritious food by growing domestic urban middle class consumer base and tourists also provides opportunities for public-private-community partnerships leading to improved market efficiency and inclusive agribusiness value chains. Investments in climate-friendly agribusiness is also expected to strengthen the financial sector, as the demand for agricultural credit will increase over time.

7. **Government's sector strategy.** The policy framework for agricultural sector is set out in the following documents: (i) 8th National Socio-Economic Development Plan, 2016-2020; (ii) National Strategy on Socio-Economic Development until 2025 and Vision until 2030; (iii) Agricultural Development Strategy (ADS) to 2025 and Vision to 2030; (iv) National Strategy on Climate Change and National Action Plan on Climate Change to 2020; and (v) Natural Resources and Environment Strategy, 2016-2025. The ADS aims to (i) ensure food security, and produce competitive agricultural commodities with comparative advantage; (ii) develop clean, safe and sustainable agriculture; and (iii) move gradually to the modernization of a resilient and productive agriculture sector. The project supports key elements of the ADS through support to rice, the most important crop, and vegetables, the subsector with the greatest potential for increasing rural incomes, by fostering backward and forward linkages and invest along the entire value chain. The project will support the government in reaching its target of 4.7 million tons of paddy rice production with 1 million tons of quality rice earmarked for the domestic and export markets by 2020, and 5 million tons of paddy rice production with 1.5 million tons of quality rice earmarked for the domestic and export markets by 2025.

8. **Project areas.** In line with the principle of promoting regional cooperation, integration, and trade, the project will target investments along the Greater Mekong Subregion (GMS) central and east-west economic corridors in areas with comparative advantage in the production and marketing of rice and vegetables. The rice value chain will target Khammouane, Saravan, and Savannakhet provinces, and the vegetable value chain in the Vientiane Capital Administration Authority, Champasak and Sekong provinces. The project covers three out of six agro-ecological zones: Mekong Corridor zone, Vientiane Plain (Khammouane and Vientiane), and Bolovan Plateau (Champasak, Saravan, and Sekong) which are particularly suited to high value vegetables.

Profile. Vientiane.

² CSA is an approach for transforming and reorienting agricultural development under the new reality of climate change, and may be defined as "agriculture that increases productivity, enhances resilience (adaptation) reduces and/or removes greenhouse gas (mitigation) where possible and ensures the achievement of food security and development goals.

9. **Value added by ADB assistance.** ADB will help the government draw valuable lessons in investing in critical infrastructure, formulating sound agribusiness policies, addressing climate change, and enhancing private sector participation in the agricultural value chains to increase efficiency gains. The project will enhance crop diversification and farm productivity, diversify livelihood options and thereby assist smallholders transition from subsistence to commercial agriculture in project areas. The project will foster public-private partnerships, particularly in agribusiness input and output markets and marketing. The project will strengthen regional cooperation and a deeper economic integration in the GMS through harmonization of standards for delivery of safe and value-added agri-food. The project complements initiatives such as Trade Facilitation: Improved Sanitary and Phytosanitary Handling Project and GMS Core Agriculture Support Program (Phase II).

10. **Lessons.** The project design incorporates lessons from ADB and other development partner-funded projects, such as (i) Sustainable Natural Resource Management and Productivity Enhancement Project (2009-2015); (ii) Smallholder Development Project (2003-2015); (iii) Enhancing Milled Rice Production in Lao PDR Project (2009-2012) financed by the European Union; and (iv) Capacity Building for Efficient Utilization of Biomass for Bioenergy and Food Security in the GMS Project (2011-2015). Lessons call for: (i) improving critical agribusiness infrastructure; (ii) supporting enabling policy environment for agribusiness; and (iii) enhancing participation of project beneficiaries to manage and use improved infrastructure. Other lessons include: (i) allowing sufficient project duration for execution of civil works at the beginning and beneficiary training and capacity building thereafter; (ii) thorough screening of subprojects to identify viable ones with minimal safeguard concerns; (iii) limiting the geographic coverage to obtain a balance between capital investments and overhead costs; (iv) restricting the scope of activities to those that can correspond with local capacities; and (v) taking advance actions to ensure training of competent project staff, accelerate procurement and recruitment of consultants.

11. **Alignment with related policies and strategies.** The project is aligned with the government's ADS to 2025 and vision to the year 2030 and the 8th National Socio-Economic Development Plan. It is consistent with the GMS Regional Investment Framework for Agriculture, ADB's Country Partnership Strategy, 2017-2020 and Country Operations Business Plan, 2018–2020.³ The project is aligned with ADB's Operational Plan for Agriculture and Natural Resources, which aims at increasing value addition and expanded partnership with the private sector to attract investments in productivity enhancement, agro-processing, and agro-retailing.⁴

B. Sector Project Impact, Outcomes and Outputs

12. The project is aligned with the following impact: agricultural competitiveness improved through enhanced productivity, quality and safety, value addition and rural household incomes⁵. The project will have the following outcome: productive and resource efficient agribusiness value chains in project areas developed. The project will have three major outputs.

13. **Output 1: Critical agribusiness value chain infrastructure improved and made climate-resilient.** It involves rehabilitation and modernization of critical agricultural production and post-harvest infrastructure to increase production and resource efficiency, reduce post-

³ ADB. 2017. *Country Partnership Strategy: Lao People's Democratic Republic 2017–2020*. Manila; and ADB. 2017. *Country Operations Business Plan: Lao People's Democratic Republic 2018–2020*. Manila.

⁴ ADB. 2015. *Operational Plan for Agriculture and Natural Resources: Promoting Sustainable Food Security in Asia and the Pacific in 2015-2020*. Manila.

⁵ Government of Lao PDR, Ministry of Agriculture and Forestry. 2015. *Agricultural Development Strategy to 2025 and Vision to the Year 2030*. Vientiane.

harvest losses, and enhance quality and value chain links while increasing climate resilience. Key activities include (i) upgrading tertiary irrigation channels targeting at least 10,000 hectares and 6,000 households, and rehabilitating 300 water retention ponds to a climate-resilient condition; (ii) rehabilitating earth-based farm access roads to gravel-based surfaces to improve supply of inputs to farms and market access, and reduce post-harvest losses; (iii) upgrading the facilities and services offered to farmers by the state-owned rice and vegetable research centers in target provinces; and (iv) improving quality and safety of infrastructure in plant protection laboratories of the Department of Agriculture and soil testing laboratory of the Department of Agricultural Land Management.

14. The project will upgrade selected small to medium rice mills to (i) allow the separation of white and glutinous rice to improve their access to premium domestic and export markets; (ii) improve rice recovery rates; (iii) enhance rice mill capacity usage; and (iv) provide support to rice farmers groups. The project will also construct or upgrade pack houses for vegetable collection and marketing clusters to: (i) reduce post-harvest losses; (ii) improve quality and quantity of vegetables to domestic and export markets; and (iii) provide services to farmers. The project will upgrade five biofertilizer production factories to: (i) increase organic fertilizer production and operational efficiency; (ii) promote the use of organic fertilizers; and (iii) provide services and support to buyers of organic rice and vegetables. Selection criteria for infrastructure investments and envisioned procedures for development, implementation and monitoring are listed in the project administration manual. Women and other vulnerable groups will be involved in the identification and implementation of agribusiness investments.

15. **Output 2: Climate-smart agriculture promoted.** This output will focus on (i) developing climate-resilient varieties of rice and vegetables; (ii) capacity strengthening of agricultural production groups (APGs) and agribusinesses on CSA; and (iii) supporting APGs through a smallholder financing scheme to purchase and gain application knowledge of farm mechanization equipment. Capacity building for APGs will include training on group management, financial management, crop calendars, preparation of business plans, networking and marketing. Capacity building for agribusinesses will include (i) post-harvest crop handling to improve quality and market access; (ii) value addition through branding; (iii) packaging and agro-processing; (iv) contract farming; and (v) joint contract harvesting operations. Support for farm mechanization includes acquisition of small machinery for land clearance and levelling, planting, on-farm micro-irrigation, water storage and conservation, and application of agricultural inputs.

16. **Output 3: Enabling environment for climate smart agribusiness enhanced.** This output focuses on (i) formulation of climate-friendly agribusiness policies and development of standards for good agricultural practices, good manufacturing practices and organic certification; (ii) support for public-private-community partnerships, especially for contract farming and formation of joint APG-agribusiness ventures; and (iii) strengthening of institutions in green finance and climate risk sharing instruments such as crop insurance.⁶

II. METHODOLOGY AND ASSUMPTIONS

17. The economic and financial analysis of the three sample subprojects was conducted in accordance with ADB's Guidelines for the Economic Analysis of Projects and Financial

⁶ Green finance is financing of investments that provide environmental benefits (e.g., reductions in air, water, and land pollution, reductions in greenhouse gas emissions, improved energy efficiency, climate change adaptation) in the broader context of sustainable development. Green finance involves the effective management of environmental risks across the financial system (Source: UNEP, September 2015).

Management and Analysis of Projects.⁷ The sample subprojects are: (i) rice mill subproject; (ii) vegetable pack house subproject; and (iii) biofertilizer factory subprojects.

18. All three sample subprojects fall under the project's sub-output 1.3, agribusiness enterprise value chain infrastructure improved. The analysis does not cover investments in irrigation and access roads (under sub-output 1.1, critical agribusiness value chain infrastructure improved and made climate-resilient), access roads, laboratories (under sub-output 1.2, crop production infrastructure and mechanization enhanced). Nor does it cover investments in output 2 (climate smart agriculture promoted) and output 3 (enabling environment for agribusiness development strengthened).

19. The three sample subprojects were selected primarily on the basis of commodity value chains and support to organic farming. In view of limited PPTA funding resources, it was considered useful to allocate resources to subprojects that have not received much attention previously in terms of feasibility, rather than investing in subprojects for which several feasibility studies were conducted in the past. Past ADB projects such as the smallholder development project and sustainable natural resources management and productivity enhancement project (SNRMPEP) have demonstrated economic viability of small scale irrigation and road subprojects. On the other hand, no ADB projects looked at economic viability of subprojects focusing on post-harvest operations such as rice mills, vegetable pack houses and biofertilizer factories. To improve the cost-wise representativeness of the sample subprojects analyzed, a preliminary analysis was conducted for one of the identified tertiary irrigation scheme. The results are presented in Appendix 4.

20. All project support both at the farm, farmers group and agribusiness value chain investment levels will be provided per demand and the potential for increasing productivity and incomes at the farm level, through (i) improved access to on farm irrigation and roads and farm inputs; adoption of new and innovative technology and diversification into high value crops; and (ii) for financial viability at the agribusiness value chain investment level. As such, no attempt has been made to identify the scope or scale of investments, other than through the identification of candidate representative subprojects. On this basis, no analysis has been undertaken for the project as a whole.

21. The public infrastructure to be built by the project will be climate-resilient to withstand climate risks such as flooding. Some examples of the climate-resilient engineering design include (i) concrete pavement; (ii) reinforced foundation that is tolerant to submersion; (iii) gentle slope to reduce soil erosion due to water run off from the concrete pavement; and (iv) use of climate-resilient building materials. These features generally entails higher initial construction costs, but also reduce the requirement and frequency of future maintenance, and extends the economic life of the infrastructure.

22. In case of Lao PDR, very few authentic studies on incremental costs and benefits of adaptation have been conducted. Therefore, the computation of adaptation costs is coarse and is dependent on rough estimates by the consulting teams based on available information from literature. For example, it is estimated that additional costs of improving tertiary canal system to cope with floods is about 18-25%, while such costs in case of post-harvest facilities can be as low as 5-6%. On the other hand, deployment of climate-resilient rice and vegetable varieties is

⁷ ADB. 2017. *Guidelines for the Economic Analysis of Projects*. Manila; and ADB. 2005. *Financial Management and Analysis of Projects*. Manila.

counted as 100% as the entire investment is considered to contribute to climate resilience.

23. In the analysis, no attempt has been made to incorporate these benefits, although the costs are inclusive of climate-resilient engineering features. This assumption would result in a higher cost and produces more conservative estimates on the economic viability.

24. The assumptions used in the economic analysis are as follows:

- (i) The analytical time frame for the subprojects is for 15 years, and so are the assumed economic life of the civil works to be constructed under the subprojects. Machinery and equipment have an economic life of 10 years, and require replacement on the eleventh year;
- (ii) The analysis assumes that investments on civil work, machinery and equipment have no salvage value of at the end of the analytical time frame;
- (iii) Costs and benefits are expressed in constant 2018 price level and are valued using the domestic (Kip) price numeraire;
- (iv) The assumed real exchange rate is Kip 8,325 per \$1.00;
- (v) Taxes and duties, interest and price contingencies are excluded from the economic cost, however, physical contingencies are included;
- (vi) Economic prices are derived from financial prices by first subtracting from the latter any embedded taxes and duties. Secondly, the net of tax financial value is decomposed by its content (tradable, non-tradable, skilled labor and unskilled labor). As the analysis uses domestic price numéraire, the local content need no adjustment. The foreign content is multiplied by the shadow exchange rate factor (SERF). Skilled labor content requires no adjustment, and unskilled labor content is multiplied by the shadow wage rate factor (SWF). Summing the adjusted values for the local, foreign, and unskilled labor content yield the economic price.
- (vii) A SERF factor of 1.03 is used for foreign content. The derivation is presented in Appendix 1;
- (viii) A SWF factor of 0.8 is used for unskilled labor content;⁸
- (ix) The economic opportunity cost of capital (EOCC) is 9%; and
- (x) The projected financial statements consisting of the income statement and cash flow statement are stated at current prices, in order to test the beneficiary's debt servicing capacity. Inflation is 1.5% between 2018 and 2020, and 1.6% thereafter for foreign currency costs; 1.5% in 2018, 2.0% in 2019, and 2.5% thereafter for local currency costs; conversion between currencies assumes purchasing power parity.

III. RICE MILL SUBPROJECT

A. Economic Analysis

25. **Present and with project situations.** The existing Vanida Rice Mill equipment is of low technology. Quality of rice produced is of lesser grade compared to the quality of rice sold at premium domestic and export markets. Existing equipment cannot attain a 60% minimum recovery of milled white rice. Equipment is used for the production of mixed rice types (white and glutinous rice). Storage facility is limited and cannot accommodate increased production.

⁸ Based on previous projects.

26. The project will support the upgrading of the Vanida Rice Mill to: (i) construct separate paddy and milled rice storage areas to comply with good manufacturing practice and hazard critical control points certification and compliance regulations; and (ii) extend the mill's production facilities to include a second production line to allow the separation of white and glutinous rice and avoid the production of mixed rice types. The upgrading of the mill will improve its access to premium domestic and export markets, improve rice recovery rates and enhance mill capacity usage.

27. **Subproject costs.** The total project costs consist of four categories: (i) investment costs; (ii) prorated project management and financial management entity (FME) consulting services costs; (iii) routine operation and maintenance (O&M) costs; and (iv) paddy purchase costs. Investment costs and prorated project management costs are presented in Table 1 and 2. O&M and paddy purchase costs are discussed in subsequent section.

28. Initial investment costs include land, civil work, and equipment costs. The new line of processing equipment will be installed inside the existing plant while the storage facilities will be constructed at the vacant idle space of the existing site. The economic life of civil work is taken to be 15 years, and that of equipment is 10 years. The equipment will be replaced in eleventh year of operation. The total initial subproject investment costs in financial prices are \$722,925 (or Kip 5,873 million), of which \$400,000 for storage facilities and the remaining amount for the equipment and certification.

29. Of the total investment costs of \$722,925, 60% will be financed by the project in the form of a matching grant, and 40% by the subproject owners. The analysis assumed that the subproject owners will raise 10% equity and take commercial loans for the remaining 30%.⁹ This assumption will not affect the economic analysis which is conducted at the project level, regardless of financing sources. However, the financing structure will affect the subproject's debt servicing capacity, which is examined in the financial analysis.

30. The economic value of each investment item is derived by first removing the taxes from the financial value, and secondly by decomposing the net-of tax financial value into four content categories (tradable, non-tradable, skilled, and unskilled labor) and converting the financial values of each content into economic values using appropriate conversion factors. In economic prices, subproject costs are \$641,659 (Table 1).

Table 1: Investment Costs in Financial and Economic Prices – Rice Mill Subproject
(\$)

	Financial price	Tax rate (%)	Financial price (net of tax)	Decomposition (%)				Economic price
				Tradable	Non-tradable	Skilled labor	Unskilled labor	
Conversion factor				1.03	1.00	1.00	0.80	
Land	0	0	0	0	100	0	0	0
Civil Work								
Storage (paddy rice)	300,000	12	267,857	35	50	5	10	265,313
Storage (finished product)	100,000	12	89,286	35	50	5	10	88,438

⁹ The project will recruit an independent and professional consulting firm (referred to as FME, in other documents) to select grant applicants through an open and competitive process, based on the proposed investment's financial viability, grant applicants' capacity in executing the investment, and the investment's alignment with broader project objectives, such as commitments to support smallholder or female farmers, to promote CSA, or to adopt resource efficient technologies. Applicants which demonstrate a greater level of commitment (e.g., readiness to raise more equity, or to enter into formal agreements with farmers groups) will rank higher, increasing the likelihood of being selected. Details of the matching grant scheme is presented in the supplementary document.

Equipment								
Pre-cleaner (3 tons per hour [t/h])	10,000	15	8,696	85	15	0	0	8,917
Paddy separator (3t/h)	9,000	15	7,826	85	15	0	0	8,026
Paddy husker (3t/h)	15,000	15	13,043	85	15	0	0	13,376
Adhesive whitener	12,000	15	10,435	85	15	0	0	10,701
Rice polisher	12,000	15	10,435	85	15	0	0	10,701
Rotary shifter	7,500	15	6,522	85	15	0	0	6,688
Rice grader	9,000	15	7,826	85	15	0	0	8,026
Color sorter (320 channels)	50,000	15	43,478	85	15	0	0	44,587
Weight + sewing machine	9,000	15	7,826	85	15	0	0	8,026
Dryer (25 tons)	150,000	15	130,435	85	15	0	0	133,761
Certification	5,000	10	4,545	0	100	0	0	4,545
Base cost	688,500							611,103
Physical contingencies	34,425							30,555
Total capital cost	722,925							641,659

Source: Consultants' estimates.

31. In addition to direct investment costs, the project will incur expenses on project management activities, which includes consulting services of an independent and professional FME which will be tasked with grant recipients' selection and capacity building support, in the area of business plan development, financial management, and commercial loans applications. Since these indirect project management and FME consulting services costs are not directly attributable to a sample subproject, they are prorated and included as an indirect investment costs. Prorated project management and associated costs per dollar of direct investment are presented in Table 2. The total budget allocation for output 1.3 (Agribusiness enterprise value chain infrastructure improved) is \$11.83 million, and the associated prorated project management and capacity building costs sum to \$5.90 million (Appendix 2).¹⁰ On average, every dollar spent on the sample subprojects will incur a cost of \$0.499 (Kip 4,042) for project management and capacity building activities. For the rice mill subproject, the prorated financial cost is \$354,233 (\$722,925 x 0.449), or Kip 24.32 million (Kip 6,018 million x 4,042).

Table 2: Prorated Project Management and Associated Costs
(\$)

	Financial price	Tax	Financial price (net of tax)	Decomposition				Economic Price
				Tradable	Non-tradable	Skilled	Unskilled	
Conversion factors				1.03	1.00	1.00	0.80	
Output 1.3 Agribusiness enterprise value chain infrastructure improved (A)	11.83	1.40	10.43	5.15	3.93	0.50	0.80	10.38
Output 2.2 Capacity in climate smart agriculture strengthened (B)								
Training of trainers	0.16	0.01	0.14	0.04	0.11	0.00	0.00	0.14
Training for farmers, APGs, enterprise owners, and research centers and laboratory staff	2.31	0.20	2.11	0.54	1.58	0.00	0.00	2.13
Output 3.2 Green finance initiatives (C)								
Training for PFIs	0.17	0.01	0.15	0.04	0.12	0.00	0.00	1.28
Project management and support (D)								
Project staffing and consultancy ^a	2.73	0.25	2.46	0.17	1.28	0.65	0.00	2.20
Project staff training	0.01	0.00	0.01	0.00	0.01	0.00	0.00	0.01
Project administration and operating expenses	0.53	0.07	0.46	0.09	0.34	0.00	0.00	0.46

¹⁰ Derivation of the prorated PM costs is presented in Appendix 2.

Total project costs to be prorated to sample subproject (E=B+C+D)	5.90	0.55	5.34	0.87	3.43	0.65	0.00	6.23
Prorated project management per dollar of direct investment cost (F=E/A)								
\$	0.4990							
Kip (Kip 8,325/\$)	4,042	2,235	1,807	1,627	6,202	1,177	0	9,006

APG = agricultural production group, PFI = participating financial institution.

^a Includes FME consulting service costs.

Source: Consultants' estimates.

32. **Subproject benefits.** The direct and quantifiable benefits of the subproject come from the net margins of the outputs generated from the new rice mill production line. These are benefits that accrue from the purchase of paddies from farmer groups, storing them in the new paddy storage facility with adequate space, and processing them into high quality product that could fetch premium domestic and export market prices. Only these benefits are quantified and included in the economic analysis.

33. The subproject will benefit cooperative members who will access the smallholder financing scheme that will be established out of the repayment proceeds of the subproject equipment that Vanida Rice Mill will pay to the cooperative. The farmer groups that supply the mill with their paddies will benefit from the increased paddy requirements of the mill. Labor that will be employed under the subproject will likewise benefit.

34. Paddy requirements of rice mill expressed in tons per year, list of milling output products with their respective percentage shares, and the prices of paddy and output products are presented in Table 3. These values are used in quantifying economic benefits of the subproject.

Table 3: Input and Output – Rice Mill Subproject

Item	Price (Kip/kg)		Input (tons/year)	Milling output (%)
	Buying	Selling		
Paddy	2,300		2,880	
White or head rice		4,209		60
Rice husk		200		17
Rice bran		1,800		15
Broken rice		2,500		5
Impurities		0		3

kg = kilogram.

Source: Consultants' estimates.

35. Recurrent O&M costs consist of variable and fixed components. O&M costs are presented in Table 4.

Table 4: Operating and Maintenance Costs – Rice Mill Subproject

Item	Cost	
Fixed		
Supervision	60	Kip million per year
Others	40	Kip million per year
Variable		
Direct labor	50	Kip per kg processed
Utilities	100	Kip per kg processed
Supplies	100	Kip per kg processed
Transportation	50	Kip per kg processed

kg = kilogram.

Source: Consultants' estimates.

36. **Working capital.** Accounts receivable are expected to amount approximately 5% of gross sales. Accounts payable are expected to amount to 10% of operating costs. Lastly, the rice mill would maintain cash balances equal to 2% of the gross sales.

37. The profit generated from this project is subject to 24% of corporation income tax rate in Lao PDR. This will not affect economic analysis since it is a transfer of benefits between subproject and the government.

38. Subproject cash flow statement is provided in Table 5 to show how input and output prices (Table 3), cost data (Tables 1, 2, and 4) are incorporated into the analysis to derive the final figures in Table 9. Further, the financial prices in Table 5 are adjusted to arrive at economic prices to compute the figures in Table 6.

Table 5: Financial Cash Flow Statement – Rice Mill Subproject
(Kip million)

	Unit	Unit cost	2019	2020	2021	2022-2029	2030	2031-2034	2035
Inflows									
Sales revenue, net of VAT									
White or head rice	per ton	4.21	0	7,273	7,273	7,273	7,273	7,273	0
Rice husk	per ton	0.20	0	98	98	98	98	98	0
Rice bran	per ton	1.80	0	778	778	778	778	778	0
Broken rice	per ton	2.50	0	360	360	360	360	360	0
Impurities	per ton	0.00	0	0	0	0	0	0	0
Total revenue			0	8,509	8,509	8,509	8,509	8,509	0
Change in AR			0	(425)	(10)	(10)	(10)	(10)	415
Net inflows			0	8,083	8,498	8,498	8,498	8,498	415
Outflows									
Project capital costs									
Land	\$/hectare	0	0	0	0	0	0	0	0
Storage (paddy rice)	\$/unit	300,000	2,461	0	0	0	0	0	0
Storage (finished product)	\$/unit	100,000	820	0	0	0	0	0	0
Pre-cleaner (3t/h)	\$/unit	10,000	82	0	0	0	69	0	0
Paddy separator (3t/h)	\$/unit	9,000	74	0	0	0	62	0	0
Paddy husker (3t/h)	\$/unit	15,000	123	0	0	0	104	0	0
Adhesive whitener	\$/unit	12,000	98	0	0	0	83	0	0
Rice polisher	\$/unit	12,000	98	0	0	0	83	0	0
Rotary shifter	\$/unit	7,500	62	0	0	0	52	0	0
Rice grader	\$/unit	9,000	74	0	0	0	62	0	0
Color sorter (320 channels)	\$/unit	50,000	410	0	0	0	345	0	0
Weight + sewing machine	\$/unit	9,000	74	0	0	0	62	0	0
Dryer (25 tons)	\$/unit	150,000	1,230	0	0	0	1,035	0	0
	\$/ lump sum								
Certification	sum	5,000	41	0	0	0	35	0	0
Physical contingencies	5%	5%	5%	282	0	0	0	100	0
Total investment costs				5,929	0	0	0	2,091	0
Prorated Project Management									
Cost	Kip	4,042	24	0	0	0	0	0	0
O&M costs									
Fixed									
Supervision	per year	60	0	60	60	60	60	60	0
Others	per year	40	0	40	40	40	40	40	0
Variable									
Direct labor	Kip/kg	50	0	144	144	144	144	144	0
Utilities	Kip/kg	100	0	288	288	288	288	288	0
Supplies	Kip/kg	100	0	288	288	288	288	288	0
Transport	Kip/kg	50	0	144	144	144	144	144	0

	Unit	Unit cost	2019	2020	2021	2022-2029	2030	2031-2034	2035
Total operating costs			0	964	964	964	964	964	0
Paddy purchase cost	per ton	2.30	0	6,624	6,624	6,624	6,624	6,624	0
Net VAT liability			(635)	(99)	(99)	(99)	(314)	(99)	0
Change in AP			0	(759)	(19)	(19)	(19)	(19)	740
Change in CB			0	170	4	4	4	4	(166)
Corporate income tax	%	24%	0	78	93	107	152	155	0
Net outflows			5,319	6,978	7,567	7,581	9,503	7,629	574
Net resource flow			(5,319)	1,105	931	917	(1,004)	869	(159)

AP = accounts payable, AR = accounts receivable, CB = cash balance, kg = kilogram, O&M = operations and maintenance, t/h = tons per hour, VAT = value added tax.

Source: Consultants' estimates.

39. **Results of economic analysis.** Overall, the economic internal rate of return (EIRR) of the subproject is 17.8%, and the economic net present value (ENPV) at 9% discount rate is Kip 2,709 million. The summary economic resource flow statement is provided in Table 6.

Table6: Summary Economic Resource Flow Statement – Rice Mill Subproject
(Kip million)

Year	Investment costs	Prorated PM costs	O&M costs	Paddy purchase costs	Change in AP	Change in CB	Sales revenue, net of VAT	Change in AR	Net resource flow
2019	5,263	53	0	0	0	0	0	0	(5,316)
2020	0	0	836	6,823	(759)	170	8,727	(425)	1,231
2021	0	0	836	6,823	(19)	4	8,727	(10)	1,072
2022	0	0	836	6,823	(19)	4	8,727	(10)	1,072
2023	0	0	836	6,823	(19)	4	8,727	(10)	1,072
2024	0	0	836	6,823	(19)	4	8,727	(10)	1,072
2025	0	0	836	6,823	(19)	4	8,727	(10)	1,072
2026	0	0	836	6,823	(19)	4	8,727	(10)	1,072
2027	0	0	836	6,823	(19)	4	8,727	(10)	1,072
2028	0	0	836	6,823	(19)	4	8,727	(10)	1,072
2029	0	0	836	6,823	(19)	4	8,727	(10)	1,072
2030	1,864	0	836	6,823	(19)	4	8,727	(10)	(792)
2031	0	0	836	6,823	(19)	4	8,727	(10)	1,072
2032	0	0	836	6,823	(19)	4	8,727	(10)	1,072
2033	0	0	836	6,823	(19)	4	8,727	(10)	1,072
2034	0	0	836	6,823	(19)	4	8,727	(10)	1,072
2035	0	0	0	0	740	(166)	0	415	(159)
ENPV	5,985	53	6,739	54,996	(642)	144	70,345	(360)	2,709
EIRR									17.8%

AP = accounts payable, AR = accounts receivable, CB = cash balance, EIRR = economic internal rate of return, ENPV = economic net present value, O&M = operation and maintenance, PM = project management, VAT = value added tax.

Source: Consultants' estimates.

B. Financial Analysis

40. **Financing plan.** The subproject financing plan is summarized in Table 7. As mentioned, the project will provide up to 60% of the financing in the form of a matching grant, while the subproject owners will raise the remaining 40% by a combination of commercial loans and own equity. While grant applicants that are prepared to shoulder more than 40% of investment costs will be ranked higher, the matching grant scheme will not prescribe the exact ratio between commercial loans and equity. It is anticipated that beneficiaries are unlikely to provide the entire 40% with equity alone.¹¹ The financial analysis will thus test the agribusinesses debt servicing

¹¹ The FME is tasked with assisting the grant recipients to apply for commercial loans (Para. 7).

capacity. For analytical purpose, the assumed equity and commercial loan contributions are assumed to be 10% and 30%, respectively.

41. The commercial loan will have the following terms and conditions: (i) competitive market interest rate of 13% per annum; (ii) repayment period of 5 years for the principal repayment; (iii) repayment of the loan principal in equal amounts; and (iv) a grace period of 1 year for the principal repayment.

Table7: Financing Plan – Rice Mill Subproject

Source	Amount (\$)	Percentage
Project grant	433,755	60%
Beneficiary contribution		
Commercial loan	216,878	30%
Equity	72,293	10%
Total	722,925	100%

Source: Consultants' estimates.

42. **Weighted average cost of capital.** The calculation of the weighted average cost of capital (WACC) of the subproject is presented in Table 8.

Table8: Weighted Average Cost of Capital – Rice Mill Subproject

	Project	Beneficiary		Total
		Commercial Loan	Equity	
Weight (%)	60.0%	30.0%	10.0%	100.0%
Nominal Cost (%)	8.0%	13.0%	20.0%	
Tax Rate (%)	0.0%	24.0%	0.0%	
Tax Adjusted Nominal Cost (%)	8.0%	9.9%	20.0%	
Inflation Rate (%)	1.5%	1.5%	1.5%	
Real Cost (%)	6.4%	8.3%	18.2%	
Weighted Component of WACC (%)	3.8%	2.5%	1.8%	
WACC (Real Terms)				8.1%

WACC = weighted average cost of capital.

Source: Consultants' estimates.

43. **Results of financial analysis.** The results of the financial analysis are summarized in Table 9. The subproject is financially viable. At the project level, the financial net present value (FNPV) at WACC of 8.1% amounts to Kip 1,602 million and the financial internal rate of return (FIRR) is 13.5%.

Table 9: Summary Financial Resource Flow Statement – Rice Mill Subproject
(Kip million)

Year	Investment costs	Prorated PM costs	O&M costs	Paddy purchase costs	Net VAT liability	Change in AP	Change in CB	Corporate income tax	Sales revenue, net of VAT	Change in AR	Net resource flow
2019	5,929	24	0	0	-635	0	0	0	0	0	-5,295
2020	0	0	964	6,624	-99	-759	170	78	8,509	-425	1,105
2021	0	0	964	6,624	-99	-19	4	93	8,509	-10	931
2022	0	0	964	6,624	-99	-19	4	107	8,509	-10	917
2023	0	0	964	6,624	-99	-19	4	120	8,509	-10	904
2024	0	0	964	6,624	-99	-19	4	133	8,509	-10	891
2025	0	0	964	6,624	-99	-19	4	145	8,509	-10	878
2026	0	0	964	6,624	-99	-19	4	148	8,509	-10	876
2027	0	0	964	6,624	-99	-19	4	150	8,509	-10	874
2028	0	0	964	6,624	-99	-19	4	152	8,509	-10	871

2029	0	0	964	6,624	-99	-19	4	155	8,509	-10	869
2030	2,091	0	964	6,624	-314	-19	4	152	8,509	-10	-1,004
2031	0	0	964	6,624	-99	-19	4	155	8,509	-10	869
2032	0	0	964	6,624	-99	-19	4	157	8,509	-10	867
2033	0	0	964	6,624	-99	-19	4	159	8,509	-10	865
2034	0	0	964	6,624	-99	-19	4	161	8,509	-10	863
2035	0	0	0	0	0	740	-166	0	0	415	-159
FNPV	6,813	24	8,180	56,210	-1,567	-630	141	1,100	72,203	-353	1,602
FIRR											13.5%

AP = accounts payable, AR = accounts receivable, CB = cash balance, FIRR = financial internal rate of return, FNPV = financial net present value, O&M = operation and maintenance, PM = project management, VAT = value added tax. Source: Consultants' estimates.

44. **Financial sustainability.** The financial projections (income statement and cash flow statement) of the subproject for the period 2019-2035 show that the subproject is financially sustainable. Internal cash generated from operations is sufficient to repay debt service obligations. Over the 5-year debt repayment period, the average and minimum debt service coverage ratio (DSCR) are 1.91 and 1.70, respectively (Table 10).

Table 10: Debt Servicing Capacity – Rice Mill Subproject
(Kip million)

Year	Loan Disbursements	Interest Paid	Principal Repayment	Total Loan Repayment	Net inflows	Net outflows	Net cash flow available for debt repayment	DSCR
2019	1,805	0	0	0	0	5,319	-5,319	0.00
2020	0	235	361	596	8,083	6,978	1,105	1.85
2021	0	188	361	549	8,498	7,567	931	1.70
2022	0	141	361	502	8,498	7,581	917	1.83
2023	0	94	361	455	8,498	7,595	904	1.99
2024	0	47	361	408	8,498	7,607	891	2.18
							Average DSCR	1.91
							Minimum DSCR	1.70

CFADS = cash flow available for debt service, DSCR = debt service coverage ratio. Source: Consultants' estimates.

45. Since the sample subprojects are revenue-generating, and subproject beneficiaries captures a significant share of the benefits, they will be responsible for the routine and periodic O&M of the investments.¹² For the rice mill subproject, the annual operating costs including routine maintenance is estimated to be Kip 964 million. It is assumed that equipment requires replacement in the eleventh year (2030) of operations. For all years except 2030, the net operating cash flow is always positive, indicating sufficient financial capacity to pay for operating costs. As for year 2031, the net operating cash flow is negative due to equipment replacement. In reality, the negative balance will be resolved with another loan, or more likely by drawing on cumulated operating cash flows.

46. **Sensitivity analysis.** The results of the sensitivity analysis are summarized in Table 11. The sensitivity tests show that the project outcomes are most vulnerable to selling price of the rice products: 8.27% decrease in price of rice will make the ENPV equal to zero. Capital and O&M

¹² Appendix 3 presents an analysis on the civil work and equipment O&M requirement for the non-revenue generating public investments, under Suboutput 1.1 (climate-resilient communal rural infrastructure improved) and 1.2 (crop research, protection and testing infrastructure enhanced). In summary, the total annual O&M is estimated to be \$0.64 million at completion (2023 or 2024), and is not considered to create excessive burden to the government.

costs have relatively little impact on the project outcome and would not affect the long-term viability of the project.

Table 11: Sensitivity Analysis – Rice Mill Subproject

Sensitivity Test	Minimum DSCR	FIRR (%)	EIRR (%)	ENPV ^a (Kip million)	SI ^b	SV ^c (%)
Base Case	1.70	13.5%	17.8%	2,709		
+10% investment cost	1.57	11.51%	15.4%	2,105	-2.23	44.86%
+10% O&M costs	1.58	11.73%	15.8%	2,043	-2.46	40.69%
-5% selling price margin	1.42	9.26%	12.7%	1,071	12.10	-8.27%

DSCR = minimum debt service coverage ratio, ENPV = economic net present value, EIRR = economic internal rate of return, FIRR = financial internal rate of return, SI = sensitivity indicator, SV = switching value, O&M = operation and maintenance.

^a Discounted at economic opportunity cost of capital of 9%.

^b Ratio of percentage change in ENPV to percentage change in a variable.

^c Percentage change in a variable to reduce the ENPV to zero.

Source: Consultant's estimates.

IV. VEGETABLE COLLECTION AND CLEANING CENTER SUBPROJECT

A. Economic Analysis

47. **Present and with project situations.** The subproject site is in Thongset village, Pakxong district, Champasak province. Currently, the vegetable farmers group does not have its own pack house. They sell individually their produce to the local and border-trade markets. Consequently, the members face regular price fluctuations and losses. The project will support the establishment of a vegetable pack house to facilitate the collection, storage, washing, drying, packing and marketing of produce grown by group members. The center would help farmers to reduce post-harvest losses, improve quality and quantity of high value vegetables marketed to premium domestic markets and export markets, particularly Thailand.

48. **Subproject costs.** The total project costs consist of four categories: (i) investment costs; (ii) prorated project management and FME consulting services costs; (iii) routine O&M costs; and (iv) vegetable purchase costs. Investment costs are presented in Table 12. O&M and vegetable purchase costs are discussed in subsequent section.

49. Initial investment costs include land, civil work, and equipment costs. New vegetable collection and pack house will be constructed with all necessary processing equipment. The economic life of civil work is taken to be 15 years, and that of equipment is 10 years. The total initial subproject investment costs in financial prices are \$217,035 (or Kip 1,763 million), of which \$32,000 is for land, \$72,600 for vegetable collection and pack house and the remaining amount for the equipment and certification.

50. Of the total investment costs of \$217,035, 60% will be financed by the project in the form of a matching grant, and 40% by the subproject owners. The analysis assumed that the subproject owners will raise 10% equity and take commercial loans for the remaining 30%. This assumption will not affect the economic analysis which is conducted at the project level, regardless of financing sources. However, the financing structure will affect the subproject's debt servicing capacity, which is examined in the financial analysis.

51. The economic value of each investment item is derived by first removing the taxes from the financial value, and secondly by decomposing the net of tax financial value into four content categories (tradable, non-tradable, skilled, and unskilled labor) and converting the financial values of each content into economic values using appropriate conversion factors. In economic prices, subproject costs are \$196,548 (Table 12).

Table 12: Investment Costs in Financial and Economic Prices – Vegetable Pack House Subproject
(\$)

	Financial price	Tax rate (%)	Financial price (net of tax)	Decomposition (%)				Economic Price
				Tradable	Non-tradable	Skilled labor	Unskilled labor	
Conversion factor				1.03	1.00	1.00	0.80	
Land	32,000	0%	32,000	0%	100%	0%	0%	32,000
Civil work	72,600	12%	64,821	35%	50%	5%	10%	64,206
Equipment								
Washing machine	2,100	15%	1,826	85%	15%	0%	0%	1,873
Grading machine	3,200	15%	2,783	85%	15%	0%	0%	2,854
Cold room, 4 tons	21,000	15%	18,261	85%	15%	0%	0%	18,727
Air conditioner	5,250	15%	4,565	85%	15%	0%	0%	4,682
Refrigerated truck, 3 tons	32,000	15%	27,826	85%	15%	0%	0%	28,536
Refrigerated system including installation	15,750	15%	13,696	80%	15%	0%	5%	13,887
Non-refrigerated truck	15,750	15%	13,696	85%	15%	0%	0%	14,045
Electric power source including installation	1,050	15%	913	80%	15%	0%	5%	926
Certification (GAP, GMP, HACCP)	6,000	10%	5,455	0%	100%	0%	0%	5,455
Base cost	206,700							187,188
Physical contingencies	10,335							9,359
Total capital cost	217,035							196,548

GAP = good agricultural practice, GMP = good manufacturing practice, HACCP = hazard critical control points.

Source: Consultants' estimates.

52. In addition to direct investment costs, the project will incur expenses on project management activities, which includes consulting services of an independent and professional FME which will be tasked with grant recipients selection and capacity building support, in the area of business plan development, financial management and commercial loans applications. Since these indirect project management and FME consulting services costs are not directly attributable to a sample subproject, they are prorated and included as an indirect investment costs. Prorated project management and associated costs per dollar of direct investment are presented in Table 2. The total budget allocation for output 1.3 (agribusiness enterprise value chain infrastructure improved) is \$11.83 million, and the associated prorated project management and capacity building costs sum to \$5.90 million (Appendix 2)¹³. On average, every dollar spent on the sample subprojects will incur a cost of \$0.499 (or Kip 4,042) for project management and capacity building activities. For the vegetable subproject, the prorated financial cost is \$97,449 (\$217,035 x 0.449), or Kip 7.3 million (Kip 1,807 million x 4,042).

53. **Subproject benefits.** Without the project, the vegetables are subject to high post-harvest loss during transportation to local markets, and prices are more influenced by seasonal variations. With the project, however, vegetables will be purchased from group members, and then cleaned, packaged, and marketed to premium domestic and export markets. The pack houses will help farmer group members to create and retain value added. The direct and quantified subproject benefits of the subproject is due to the net margins, that is, the difference in total operating costs including vegetable procurement costs and revenue from cleaned and packed vegetables.

54. At the upstream, the subproject will improve productivity and farm profitability, reduce post-harvest losses, attract and increase group membership, and enhance rural household incomes. The subproject will contribute to the local business development. Labor that will be employed under the subproject will likewise benefit.

55. Input and output prices of vegetables, input requirements of the vegetable pack house expressed in tons per year, process losses are summarized in Table 13. These data are used in quantifying the benefits and the costs of the subproject.

Table 13: Input and Output – Vegetable Pack House Subproject

Item	Price (Kip/kg)		Input (tons/year)	Process Loss (%)
	Buying	Selling		
Eggplant	3,000	4,200	75	7%
White raddish	5,000	7,000	66	7%
Thai green eggplant	3,000	4,200	75	7%
Chili	5,000	7,000	66	7%
Spring onion	8,000	11,200	66	7%
Pakchoi	3,000	4,200	66	7%
Salad	5,000	7,000	66	7%

kg = kilogram.

Source: Consultants estimates.

56. Recurrent O&M costs consist of variable and fixed components. O&M costs are presented in Table 14.

¹³ Derivation of the prorated project management costs is presented in Appendix 2.

Table 14: Operation and Maintenance Costs – Vegetable Pack House Subproject

<u>Item</u>	<u>Cost</u>	
Fixed		
Supervision	170	million Kip per year
Others	130	million Kip per year
Variable		
Direct labor	50	Kip per kg processed
Utilities	75	Kip per kg processed
Supplies	5	Kip per kg processed
Transportation	20	Kip per kg processed

Source: Consultants estimates.

57. **Working capital.** Accounts receivable are expected to amount to approximately 5% of gross sales. Accounts payable are expected to amount to 10% of operating costs. Lastly, cash balance is equal to 2% of the gross sales.

58. The profit generated from this project is subject to 24% of the corporation income tax rate in Lao PDR. This will not affect economic analysis since it is a transfer of benefits between subproject and the government.

59. Subproject cash flow statement is provided in Table 15 to show how input and output prices (Table 13), cost data (Tables 12 and 14) are incorporated into the analysis to derive the final figures in Table 19. Further, the financial prices in Table 15 are adjusted to arrive at economic prices to compute the figures in Table 16.

Table 15: Financial Cash Flow Statement – Vegetable Pack House Subproject
(Kip million)

	Unit	Unit cost	2019	2020	2021	2022-2029	2030	2031-2034	2035
Inflows									
Sales revenue, net of VAT									
Eggplant	Kip/kg	4,200	0	293	293	293	293	293	0
White raddish	Kip/kg	7,000	0	430	430	430	430	430	0
Thai green eggplant	Kip/kg	4,200	0	293	293	293	293	293	0
Chili	Kip/kg	7,000	0	430	430	430	430	430	0
Spring onion	Kip/kg	11,200	0	687	687	687	687	687	0
Pakchoi	Kip/kg	4,200	0	258	258	258	258	258	0
Salad	Kip/kg	7,000	0	430	430	430	430	430	0
Total revenue			0	2,820	2,820	2,820	2,820	2,820	0
Change in AR			0	-141	-3	-3	-3	-3	138
Net inflows			0	2,679	2,817	2,817	2,817	2,817	138
Outflows									
Project capital costs									
Land	\$/ha	32,000	262	0	0	0	0	0	0
Building	\$/unit	72,600	595	0	0	0	0	0	0
Washing machine	\$/unit	2,100	17	0	0	0	14	0	0
Grading machine	\$/unit	3,200	26	0	0	0	22	0	0
Cold room, 4 tons	\$/unit	21,000	172	0	0	0	145	0	0
Air conditioner	\$/unit	5,250	43	0	0	0	36	0	0
Refrigerated truck, 3 tons	\$/unit	32,000	262	0	0	0	221	0	0
Refrigerated system including installation	\$/unit	15,750	129	0	0	0	109	0	0
Non-refrigerated truck	\$/unit	15,750	129	0	0	0	109	0	0
Electric power source including installation	\$/unit	1,050	9	0	0	0	7	0	0
Certification (GAP, GMP, HACCP)	\$/ lump sum	6,000	49	0	0	0	41	0	0
Physical contingencies	%	5%	85	0	0	0	35	0	0

	Unit	Unit cost	2019	2020	2021	2022-2029	2030	2031-2034	2035
Total investment costs				1,780	0	0	0	740	0
Prorated Project Management Cost	Kip	4,042	7	0	0	0	0	0	0
O&M costs									
Fixed									
Supervision	per year	170	0	170	170	170	170	170	0
Others	per year	130	0	130	130	130	130	130	0
Variable									
Direct labor	Kip/kg	50	0	24	24	24	24	24	0
Utilities	Kip/kg	75	0	36	36	36	36	36	0
Supplies	Kip/kg	5	0	2	2	2	2	2	0
Transport	Kip/kg	20	0	10	10	10	10	10	0
Total operating costs			0	372	372	372	372	372	0
Vegetable purchase cost									
Eggplant	Kip/kg	3,000	0	225	225	225	225	225	0
White raddish	Kip/kg	5,000	0	330	330	330	330	330	0
Thai green eggplant	Kip/kg	3,000	0	225	225	225	225	225	0
Chili	Kip/kg	5,000	0	330	330	330	330	330	0
Spring onion	Kip/kg	8,000	0	528	528	528	528	528	0
Pakchoi	Kip/kg	3,000	0	198	198	198	198	198	0
Salad	Kip/kg	5,000	0	330	330	330	330	330	0
Total vegetable purchase costs			0		0	2,166	2,166	2,166	2,166
Net VAT liability			-171	-23	-23	-23	-113	-23	0
Change in AP			0	-254	-6	-6	-6	-6	248
Change in CB			0	56	1	1	1	1	-55
Corporate income tax	%	24%	0	19	25	31	48	48	0
Net outflows			1,616	2,336	2,535	2,541	3,207	2,558	193
Net resource flow			-1,616	343	282	276	-391	258	-55

AR = accounts receivable, AP = accounts payable, CB = cash balance, FNPV = financial net present value, ENPV = economic net present value, GAP = good agricultural practice, GMP = good manufacturing practice, ha = hectare, HACCP = hazard critical control points, kg = kilogram, O&M = operation and maintenance, VAT = value added tax.
Source: Consultants' estimates.

60. **Results of economic analysis.** Overall, the EIRR of the subproject is 19.0%, and the ENPV at 9% with a discount rate of Kip 518 million. The results of the economic analysis are summarized in Table.

Table 16: Summary Economic Resource Flow Statement – Vegetable Pack House Subproject
(Kip million)

Year	Investment costs	Prorated PM costs	O&M costs	Vegetable purchase costs	Change in AP	Change in CB	Sales revenue, net of VAT	Change in AR	Net resource flow
2019	1,612	16	0	0	0	0	0	0	-1,628
2020	0	0	310	2,166	-254	56	2,820	-141	401
2021	0	0	310	2,166	-6	1	2,820	-3	346
2022	0	0	310	2,166	-6	1	2,820	-3	346
2023	0	0	310	2,166	-6	1	2,820	-3	346
2024	0	0	310	2,166	-6	1	2,820	-3	346
2025	0	0	310	2,166	-6	1	2,820	-3	346
2026	0	0	310	2,166	-6	1	2,820	-3	346
2027	0	0	310	2,166	-6	1	2,820	-3	346
2028	0	0	310	2,166	-6	1	2,820	-3	346
2029	0	0	310	2,166	-6	1	2,820	-3	346
2030	660	0	310	2,166	-6	1	2,820	-3	-314
2031	0	0	310	2,166	-6	1	2,820	-3	346
2032	0	0	310	2,166	-6	1	2,820	-3	346

Year	Investment costs	Prorated PM costs	O&M costs	Vegetable purchase costs	Change in AP	Change in CB	Sales revenue, net of VAT	Change in AR	Net resource flow
2033	0	0	310	2,166	-6	1	2,820	-3	346
2034	0	0	310	2,166	-6	1	2,820	-3	346
2035	0	0	0	0	248	-55	0	138	-55
ENPV	1,868	16	2,109	14,740	-269	60	19,192	-150	518
EIRR									19.0%

AP = accounts payable, AR = accounts receivable, CB = cash balance, ENPV = economic net present value, EIRR = economic internal rate of return, PM = project management, O&M = operation and maintenance, VAT = value added tax.

Source: Consultants' estimates.

B. Financial Analysis

61. **Investment cost.** The subproject is estimated to cost \$317,035. In addition to the capital investment cost, the project will also provide a subsidy of \$100,000 for the management costs of the enterprise over the first five years of its operations with the objective of achieving sustainability and self-sufficiency on project completion.

62. **Financing plan.** The subproject financing plan is summarized in Table. As mentioned, the project will provide up to 60% of the financing in the form of a matching grant, while the subproject owners will raise the remaining 40% by a combination of commercial loans and own equity. While grant applicants that are prepared to shoulder more than 40% of investment costs will be ranked higher, the matching grant scheme will not prescribe the exact ratio between commercial loans and equity. It is anticipated that beneficiaries are unlikely to provide the entire 40% with equity alone.¹⁴ The financial analysis will thus test the agribusinesses' debt servicing capacity. For analytical purpose, the assumed equity and commercial loan contributions are assumed to be 10% and 30% respectively.

63. The commercial loan will have the following terms and conditions: (i) competitive market interest rate of 13% per annum; (ii) repayment period of 5 years for the principal repayment; (iii) repayment of the loan principal in equal amounts; (iv) a grace period of 1 year for the principal repayment.

Table 17: Financing Plan – Vegetable Pack House Subproject

Source	Amount (\$)	Percentage
Project grant	190,221	60%
Beneficiary contribution		
Commercial loan	94,814	30%
Equity	32,000	10%
Total	317,035	100%

Source: Consultants' estimates.

64. **Weighted average cost of capital.** The calculation of the WACC of the subproject is presented in Table 18.

Table 18: Weighted Average Cost of Capital – Vegetable Pack House Subproject

Project	Beneficiary	Total
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¹⁴ The FME is tasked with assisting the grant recipients to apply for commercial loans (Para. 7).

		Commercial Loan	Equity	
Weight (%)	60.0%	30.0%	10.0%	100.0%
Nominal Cost (%)	8.0%	13.0%	18.0%	
Tax Rate (%)	0.0%	24.0%	0.0%	
Tax Adjusted Nominal Cost (%)	8.0%	9.9%	18.0%	
Inflation Rate (%)	1.5%	1.5%	1.5%	
Real Cost (%)	6.4%	8.3%	16.3%	
Weighted Component of WACC (%)	3.8%	2.5%	1.6%	
WACC (Real Terms)				7.9%

WACC = weighted average cost of capital.

Source: Consultants' estimates.

65. **Results of financial analysis.** The results of the financial analysis are summarized in Table 19. The subproject is financially viable. At the project level, the FNPV at WACC of 7.9% is Kip 63 million and FIRR is 12.7%.

Table 19: Summary Financial Resource Flow Statement – Vegetable Pack House Subproject
(Kip million)

Year	Investment costs	Prorated PM costs	O&M costs	Vegetable purchase costs	Net VAT liability	Change in AP	Change in CB	Corporate income tax	Sales revenue, net of VAT	Change in AR	Net resource flow
2019	1,780	7	0	0	-171	0	0	0	0	0	-1,616
2020	0	0	372	2,166	-23	-254	56	26	2,820	-141	335
2021	0	0	372	2,166	-23	-6	1	31	2,820	-3	276
2022	0	0	372	2,166	-23	-6	1	35	2,820	-3	272
2023	0	0	372	2,166	-23	-6	1	39	2,820	-3	268
2024	0	0	372	2,166	-23	-6	1	43	2,820	-3	264
2025	0	0	372	2,166	-23	-6	1	46	2,820	-3	260
2026	0	0	372	2,166	-23	-6	1	47	2,820	-3	260
2027	0	0	372	2,166	-23	-6	1	48	2,820	-3	259
2028	0	0	372	2,166	-23	-6	1	48	2,820	-3	258
2029	0	0	372	2,166	-23	-6	1	49	2,820	-3	258
2030	740	0	372	2,166	-113	-6	1	48	2,820	-3	-391
2031	0	0	372	2,166	-23	-6	1	48	2,820	-3	258
2032	0	0	372	2,166	-23	-6	1	49	2,820	-3	258
2033	0	0	372	2,166	-23	-6	1	50	2,820	-3	257
2034	0	0	372	2,166	-23	-6	1	50	2,820	-3	256
2035	0	0	0	0	0	248	-55	0	0	138	-55
FNPV	2,099	7	2,663	15,504	-376	-274	61	287	20,187	-152	63
FIRR											12.7%

AP = accounts payable, AR = accounts receivable, CB = cash balance, FIRR = financial internal rate of return, FNPV = financial net present value, O&M = operation and maintenance, VAT = value added tax.

Source: Consultant's estimates.

66. **Financial sustainability.** The financial projections (income statement and cash flow statement) of the subproject for the period 2019-2030 show that the subproject is financially sustainable. Internal cash generated from operations is sufficient to repay debt service obligations. Over the 5-year debt repayment period, the average and minimum DSCRs are 1.89 and 1.67, respectively (Table 20).

Table 20: Debt Servicing Capacity – Vegetable Pack House Subproject
(Kip million)

Year	Loan Disbursements	Interest Paid	Principal Repayment	Total Loan Repayment	Operating inflows	Operating outflows	CFADS	DSCR
2019	542	0	0	0	0	1,616	-1,616	0.00
2020	0	70	108	179	2,679	2,344	335	1.87
2021	0	56	108	165	2,817	2,541	276	1.67
2022	0	42	108	151	2,817	2,545	272	1.80
2023	0	28	108	137	2,817	2,549	268	1.96
2024	0	14	108	123	2,817	2,553	264	2.16
Average DSCR								1.89
Minimum DSCR								1.67

CFADS = cash flow available for debt service, DSCR = debt service coverage ratio.

Source: Consultant's estimates.

67. Since the sample subprojects are revenue-generating, and subproject beneficiaries captures a significant share of the benefits, they will be responsible for the routine and periodic O&M of the investments. For the vegetable collection and cleaning center subproject, the annual operating costs including routine maintenance is estimated to be Kip 964 million. It is assumed that equipment requires replacement in the eleventh year (2030) of operations. For all years, the net operating cash flow is always positive, indicating sufficient financial capacity to pay for operating costs.

68. **Sensitivity analysis.** The results of the sensitivity analysis are summarized in Table 21. The subproject economic performance is most sensitive to selling price of vegetables: 5.82% decrease in selling price margin of processed vegetables would make the ENPV of the subproject equal to zero. Capital costs have little impact on the project outcome and would not affect the long-term viability of the project. O&M costs are also not a risk factor to project outcomes.

Table 21: Sensitivity Analysis – Vegetable Pack House Subproject

Sensitivity Test	Minimum DSCR	FIRR (%)	EIRR (%)	ENPV ^a (Kip million)	SI ^b	SV ^c (%)
Base Case	1.67	12.7%	19.0%	938		
+10% investment cost	1.59	11.24%	17.3%	805	-1.41	70.77%
+10% O&M costs	1.51	10.21%	16.6%	691	-2.63	38.02%
-5% selling price margin	1.21	4.83%	10.6%	132	17.18	-5.82%

DSCR = minimum debt service coverage ratio, EIRR = economic internal rate of return, ENPV = economic net present value, FIRR = financial internal rate of return, O&M = operations and maintenance, SI = sensitivity indicator, SV = switching value.

^a Discounted at economic opportunity cost of capital of 9%.

^b Ratio of percentage change in ENPV to percentage change in a variable.

^c Percentage change in a variable to reduce the ENPV to 0.

Source: Consultant's estimates.

V. BIOFERTILIZER SUBPROJECT

A. Economic Analysis

69. **Present and with project situations.** The current production line of the factory can process only 10 tons per day. The factory cannot increase its capacity due to equipment obsolescence. To increase the annual production and meet potential market demand, the factory needs to increase its capacity by installing an additional production line. The factory currently does not have a reliable factory-based testing laboratory to ensure the quality assurance of the final product.

70. The project will upgrade the physical infrastructure, production facilities and equipment of the factory by installing an additional 10 tons per day production line. In addition, the project will support the establishment of an internal control system to ensure the quality assurance of the final product. A competent and reliable factory based testing laboratory, meeting recognized industry standards, will be provided to ensure the consistent quality of raw materials and the final organic fertilizer product. The testing laboratory will be equipped with a basic set of laboratory equipment enabling it to conduct soil fertility, micro-nutrient analysis and microbiological testing.

71. **Subproject costs.** The total project costs consist of four categories: (i) investment costs; (ii) prorated project management and FME consulting services costs; (iii) routine O&M costs; and (iv) raw materials purchase costs. Investment costs are presented in Table 22. O&M and raw materials purchase costs are discussed in subsequent section.

72. Initial investment costs include land, civil work and equipment costs. The new line of processing equipment will be installed inside the existing plant while the storage facilities will be constructed at the vacant idle space of the existing site. The economic life of civil work is taken to be 15 years, and that of equipment is 10 years. The equipment will be replaced in eleventh year of operation. The total initial subproject investment costs in financial prices are \$660,450 (or Kip 5,365 million), of which \$200,000 for storage facilities and the remaining amount for the equipment and certification.

73. Of the total investment costs of \$660,450, 60% will be financed by the project in the form of a matching grant, and 40% by the subproject owners. The analysis assumed that the subproject owners will raise 10% equity and take commercial loans for the remaining 30%. This assumption will not affect the economic analysis which is conducted at the project level, regardless of financing sources. However, the financing structure will affect the subproject's debt servicing capacity, which is examined in the financial analysis.

74. The economic value of each investment item is derived by first removing the taxes from the financial value, and secondly by decomposing the net of tax financial value into four content categories (tradable, non-tradable, skilled, and unskilled labor) and converting the financial values of each content into economic values using appropriate conversion factors. In economic prices, subproject costs are \$589,361 (Table 22).

75. In addition to direct investment costs, the project will incur expenses on project management activities, which includes consulting services of an independent and professional FME which will be tasked with grant recipients' selection and capacity building support, in the area of business plan development, financial management, and commercial loans applications. Since these indirect project management and FME consulting services costs are not directly attributable to a sample subproject, they are prorated and included as an indirect investment costs. Prorated project management and associated costs per dollar of direct investment are presented in Table 2. The total budget allocation for output 1.3 (Agribusiness enterprise value chain infrastructure improved) is \$11.83 million, and the associated prorated project management and capacity building costs sum to \$5.90 million (Appendix 2).¹⁵ On average, every dollar spent on the sample subprojects will incur a cost of \$0.499 (Kip 4,042) for project management and capacity building activities. For the biofertilizer factory subproject, the prorated financial cost is \$296,542 ($\$660,450 \times 0.449$), or Kip 22.22 million (Kip 5,498 million $\times 4,042$).

¹⁵ Derivation of the prorated PM costs is presented in Appendix 2.

Table 22: Investment Costs in Financial and Economic Prices – Biofertilizer Factory Subproject
(\$)

	Financial price	Tax rate (%)	Financial price (net of tax)	Decomposition (%)				Economic Price
				Tradable	Non-tradable	Skilled labor	Unskilled labor	
Conversion factor				1.03	1.00	1.00	0.80	
Land	0	0%	0	0%	100%	0%	0%	0
Civil work								
Storage facility (raw materials)	100,000	12%	89,286	35%	50%	5%	10%	88,438
Storage facility (finished product)	100,000	12%	89,286	35%	50%	5%	10%	88,438
Equipment								
Production equipment	176,000	15%	153,043	85%	15%	0%	0%	156,946
Vehicle (truck)	47,000	15%	40,870	85%	15%	0%	0%	41,912
Laboratory equipment	98,500	15%	85,652	85%	15%	0%	0%	87,836
Biofertilizer production manual development and publication	50,000	10%	45,455	0%	100%	0%	0%	45,455
Network creation and activity	10,000	10%	9,091	0%	100%	0%	0%	9,091
Registration and certification	7,500	10%	6,818	0%	100%	0%	0%	6,818
Field demonstrations	20,000	10%	18,182	0%	100%	0%	0%	18,182
Mass media campaign	10,000	10%	9,091	0%	100%	0%	0%	9,091
Training and workshop	10,000	10%	9,091	0%	100%	0%	0%	9,091
Base cost	629,000							561,296
Physical contingencies	31,450							28,065
Total capital cost	660,450							589,361

Source: Consultants' estimates.

76. **Economic benefits.** The direct and quantifiable benefits of the subproject come from the net margins of the product generated from the new production line. These are benefits that accrue from the purchase of raw materials from different suppliers, processing them into high quality product and marketing them. Only these benefits are quantified and included in the economic analysis.

77. The subproject will benefit the suppliers that provide the factory with increased raw materials requirements for the new production line. The promotion of the bioorganic fertilizer will reduce the use and importation of chemical fertilizer from the neighboring countries, save the country some foreign exchange reserve, and contribute to the local business development. Labor that will be employed under the subproject will likewise benefit.

78. The prices of raw material and biofertilizer, the input requirements of the plant expressed in tons per year, and the process loss in percentage terms are given in Table 23. These data are used in quantifying benefits and costs of the subproject.

Table 23: Input and Output – Biofertilizer Factory Subproject

Item	Price (Kip/kilogram)		Input (tons/year)	Process Loss (%)
	Buying	Selling		
Raw material	200		1,500	5%
Biofertilizer		1,500		

Source: Consultants' estimates.

79. Recurrent O&M costs consist of variable and fixed components. O&M costs are presented in Table 24.

Table 24: Operations and Maintenance costs – Biofertilizer Factory Subproject

Item	Cost	
Fixed		
Supervision	60	million Kip per year
Others	90	million Kip per year
Variable		
Direct labor	150	Kip per kilogram (kg) processed
Utilities	100	Kip per kg processed
Supplies	150	Kip per kg processed
Transportation	100	Kip per kg processed

Source: Consultants' estimates.

80. **Working capital.** Accounts receivable are expected to amount to approximately 5% of gross sales. Accounts payable are expected to amount to 10% of operating costs. Lastly, cash balance is equal to 2% of the gross sales.

81. The profit generated from this project is subject to 24% of the corporation income tax rate in Lao PDR. This will not affect economic analysis since it is a transfer of benefits between subproject and the government.

82. Subproject cash flow statement is provided Table 25 in to show how input and output prices (Table 23), cost data (Tables 22 and 26) are incorporated into the analysis to derive the final figures in Table 29. Further, the financial prices in Table 25 are adjusted to arrive at economic prices to compute the figures in Table 26.

Table 25: Financial Cash Flow Statement – Biofertilizer Factory Subproject
(Kip million)

	Unit	Unit cost	2019	2020	2021	2022-2029	2030	2031-2034	2035
Inflows									
Sales revenue, net of VAT	per ton	1.50	0	2,138	2,138	2,138	2,138	2,138	0
Change in AR			0	-107	-3	-3	-3	-3	104
Net inflows			0	2,031	2,135	2,135	2,135	2,135	104
Outflows									
Project capital costs									
Land	\$/hectare	0	0	0	0	0	0	0	0
Storage facility (raw materials)	\$/unit	100,000	820	0	0	0	0	0	0
Storage facility (finished product)	\$/unit	100,000	820	0	0	0	0	0	0
Production equipment	\$/set	176,000	1,444	0	0	0	1,215	0	0
Vehicle (truck)	\$/unit	47,000	385	0	0	0	324	0	0
Laboratory equipment	\$/set	98,500	808	0	0	0	680	0	0
Biofertilizer production manual development and publication	\$, lump sum	50,000	410	0	0	0	0	0	0
Network creation and activity	\$, lump sum	10,000	82	0	0	0	0	0	0
Registration and certification	\$, lump sum	7,500	62	0	0	0	0	0	0
Field demonstrations	\$, lump sum	20,000	164	0	0	0	0	0	0
Mass media campaign	\$, lump sum	10,000	82	0	0	0	0	0	0
Training and workshop	\$, lump sum	10,000	82	0	0	0	0	0	0
Physical contingencies	%	5%	258	0	0	0	111	0	0
Total investment costs				5,417	0	0	0	2,330	0
Prorated Project Management Cost	Kip	4,042	22	0	0	0	0	0	0
O&M costs									
Fixed									
Supervision	per year	60	60	60	60	60	60	60	0
Others	per year	90	90	90	90	90	90	90	0
Variable									
Direct labor	Kip/kg	150	0	225	225	225	225	225	0
Utilities	Kip/kg	100	0	150	150	150	150	150	0
Supplies	Kip/kg	150	0	225	225	225	225	225	0
Transport	Kip/kg	100	0	150	150	150	150	150	0
Total operating costs			0	900	900	900	900	900	0
Raw material purchase cost	per ton	0.30	0	450	450	450	450	450	0
Net VAT liability			-600	-80	-80	-80	-370	-80	0
Change in AP			0	-90	-2	-2	-2	-2	88
Change in CB			0	43	1	1	1	1	-42
Corporate income tax	%	24%	0	66	80	92	131	133	0
Net outflows			4,839	1,289	1,348	1,361	3,440	1,402	46
Net resource flow			-4,839	742	787	774	-1,305	733	58

AP = accounts payable, AR = accounts receivable, CB = cash balance, kg = kilogram, O&M = operations and maintenance, VAT = value added tax.

Source: Consultants' estimates.

83. **Results of economic analysis.** Overall, the EIRR of the subproject is 14.8%, and the ENPV at 9% and discount rate is Kip 1,619 million. The summary economic resource flow statement is provided in Table 26.

Table 26: Summary Economic Resource Flow Statement – Biofertilizer Factory Subproject
(Kip million)

Year	Investment costs	Prorated PM costs	O&M costs	Raw material purchase costs	Change in AP	Change in CB	Sales revenue, net of VAT	Change in AR	Net resource flow
2019	4,834	49	0	0	0	0	0	0	-4,883
2020	0	0	775	450	-90	43	2,138	-107	853
2021	0	0	775	450	-2	1	2,138	-3	911
2022	0	0	775	450	-2	1	2,138	-3	911
2023	0	0	775	450	-2	1	2,138	-3	911
2024	0	0	775	450	-2	1	2,138	-3	911
2025	0	0	775	450	-2	1	2,138	-3	911
2026	0	0	775	450	-2	1	2,138	-3	911
2027	0	0	775	450	-2	1	2,138	-3	911
2028	0	0	775	450	-2	1	2,138	-3	911
2029	0	0	775	450	-2	1	2,138	-3	911
2030	2,078	0	775	450	-2	1	2,138	-3	-1,166
2031	0	0	775	450	-2	1	2,138	-3	911
2032	0	0	775	450	-2	1	2,138	-3	911
2033	0	0	775	450	-2	1	2,138	-3	911
2034	0	0	775	450	-2	1	2,138	-3	911
2035	0	0	0	0	88	-42	0	104	58
ENPV	5,639	49	6,245	3,627	-76	36	17,230	-90	1,619
EIRR									14.8%

AP = accounts payable, AR = accounts receivable, CB = cash balance, EIRR = economic internal rate of return, ENPV = economic net present value, O&M = operation and maintenance, PM = project management, VAT = value added tax. Source: Consultants' estimates.

B. Financial Analysis

84. **Financing plan.** The subproject financing plan is summarized in

Table 27. As mentioned, the project will provide up to 60% of the financing in the form of a matching grant, while the subproject owners will raise the remaining 40% by a combination of commercial loans and own equity. While grant applicants that are prepared to shoulder more than 40% of investment costs will be ranked higher, the matching grant scheme will not prescribe the exact ratio between commercial loans and equity. It is anticipated that beneficiaries are unlikely to provide the entire 40% with equity alone.¹⁶ The financial analysis will thus test the agribusinesses' debt servicing capacity. For analytical purpose, the assumed equity and commercial loan contributions are assumed to be 10% and 30% respectively.

85. The commercial loan will have the following terms and conditions: (i) competitive market interest rate of 13% per annum; (ii) repayment period of 5 years for the principal repayment; (iii) repayment of the loan principal in equal amounts; (iv) a grace period of 1 year for the principal repayment.

¹⁶ The FME is tasked with assisting the grant recipients to apply for commercial loans (Para. 7).

Table 27: Financing Plan – Biofertilizer Factory Subproject

Source	Amount (\$)	Percentage
Project grant	396,270	60%
Beneficiary contribution		
Commercial loan	198,135	30%
Equity	66,045	10%
Total	660,450	100%

Source: Consultants' estimates.

86. **Weighted average cost of capital.** The calculation of WACC of the subproject is presented in Table 28.

Table 28: Weighted Average Cost of Capital – Biofertilizer Factory Subproject

WACC	Project	Commercial Loan	Equity	Total
Weight (%)	60.0%	30.0%	10.0%	100.0%
Nominal Cost (%)	0.0%	13.0%	20.0%	
Tax Rate (%)	0.0%	24.0%	0.0%	
Tax Adjusted Nominal Cost (%)	0.0%	9.9%	20.0%	
Inflation Rate (%)	1.5%	3.5%	3.5%	
Real Cost (%)	0.0%	6.2%	15.9%	
Weighted Component of WACC (%)	0.0%	1.8%	1.6%	
WACC (Real Terms)				3.4%

WACC = weighted average cost of capital.

Source: Consultants' estimates.

87. **Results of financial analysis.** The results of the financial and sensitivity analysis are summarized in Table 29. At the project level, the FNPV at WACC of 3.4% is equal to Kip 2,492 million, and the FIRR is equal to 11%.

Table 29: Summary Financial Resource Flow Statement – Biofertilizer Factory Subproject
(Kip million)

Year	Investment costs	Prorated PM costs	O&M costs	Raw material purchase costs	Net VAT liability	Change in AP	Change in CB	Corporate income tax	Sales revenue, net of VAT	Change in AR	Net resource flow
2019	5,271	21	0	0	-584	0	0	0	0	0	-4,708
2020	0	0	900	450	-80	-90	43	71	2,138	-107	737
2021	0	0	900	450	-80	-3	1	84	2,138	-3	782
2022	0	0	900	450	-80	-3	1	97	2,138	-4	768
2023	0	0	900	450	-80	-3	1	110	2,138	-4	756
2024	0	0	900	450	-80	-3	1	122	2,138	-4	744
2025	0	0	900	450	-80	-3	1	133	2,138	-4	733
2026	0	0	900	450	-80	-3	1	135	2,138	-4	730
2027	0	0	900	450	-80	-3	1	138	2,138	-4	728
2028	0	0	900	450	-80	-3	1	140	2,138	-4	726
2029	0	0	900	450	-80	-3	1	142	2,138	-4	723
2030	2,287	0	900	450	-364	-3	1	135	2,138	-4	-1,272
2031	0	0	900	450	-80	-3	1	137	2,138	-4	728
2032	0	0	900	450	-80	-3	1	140	2,138	-4	726
2033	0	0	900	450	-80	-3	1	142	2,138	-4	724
2034	0	0	900	450	-80	-3	1	144	2,138	-4	722
2035	0	0	0	0	0	87	-41	0	0	103	58
FNPV	6,846	21	10,407	5,204	-1,707	-68	32	1,408	24,718	-81	2,492
FIRR											11.0%

AP = accounts payable, AR = accounts receivable, CB = cash balance, FIRR = financial internal rate of return, FNPV = financial net present value, O&M = operations and maintenance, VAT = value added tax.

Source: Consultant's estimates.

88. **Financial sustainability.** The financial projections (income statement and cash flow statement) of the subproject for the period 2019-2035 show that the subproject is financially sustainable. Internal cash generated from operations is sufficient to repay debt service obligations. Over the 5-year debt repayment period, the minimum and average DSCRs are calculated as 1.39 and 1.72, respectively (Table 30).

Table 30: Debt servicing capacity - Biofertilizer Factory Subproject
(Kip million)

Year	Loan Disbursements	Interest Paid	Principal Repayment	Total Loan Repayment	Operating inflows	Operating outflows	CFADS	DSCR
2019	1,610	0	0	0	0	4,708	-4,708	0.00
2020	0	209	322	531	2,031	1,293	737	1.39
2021	0	167	322	489	2,134	1,353	782	1.60
2022	0	126	322	447	2,134	1,366	768	1.72
2023	0	84	322	406	2,134	1,378	756	1.86
2024	0	42	322	364	2,134	1,390	744	2.05
							Average DSCR	1.72
							Minimum DSCR	1.39

CFADS = cash flow available for debt service, DSCR = debt service coverage ratio.

Source: Consultant's estimates.

89. Since the sample subprojects are revenue-generating, and subproject beneficiaries captures a significant share of the benefits, they will be responsible for the routine and periodic O&M of the investments. For the biofertilizer factory subproject, the annual operating costs including routine maintenance is estimated to be Kip 900 million. It is assumed that equipment requires replacement in the eleventh year (2030) of operations. For all years except 2030, the net operating cash flow is always positive, indicating sufficient financial capacity to pay for operating costs. As for year 2031, the net operating cash flow is negative due to equipment replacement. In reality, the negative balance will be resolved by another loan, or more likely by drawing on cumulated operating cash flows.

90. **Sensitivity analysis.** The results of the sensitivity analysis are summarized in Table 31. The project outcomes are most sensitive to biofertilizer price being below expectations: 10.3% decrease in price of biofertilizer would make the ENPV of the subproject equal to zero. The project outcomes are not very sensitive to the cost of raw materials and investment costs. O&M costs are also not a risk factor for the project outcomes.

Table 31: Sensitivity Analysis – Biofertilizer Factory Subproject

Sensitivity Test	Minimum DSCR	FIRR (%)	EIRR (%)	ENPV ^a (Kip millions)	SI ^b	SV ^c (%)
Base Case	1.36	10.6%	14.8%	1,619		
+10% investment cost	1.26	8.8%	12.5%	1,050	-3.51	28.5%
+10% cost of raw materials	1.30	9.6%	13.6%	1,256	-2.24	44.6%
+10% O&M costs	1.26	8.7%	12.7%	1,002	-3.81	26.2%
-5% selling price of biofertilizer	1.23	8.1%	11.8%	764	10.56	-9.5%

DSCR = minimum debt service coverage ratio, EIRR = economic internal rate of return, ENPV = economic net present value, FIRR = financial internal rate of return, O&M = operations and maintenance, SI = sensitivity indicator, SV = switching value.

^a Discounted at economic opportunity cost of capital of 9%.

^b Ratio of percentage change in ENPV to percentage change in a variable.

^c Percentage change in a variable to reduce the ENPV to 0.

Source: Consultant's estimates.

91. **Distribution analysis.** The benefits and costs of the subproject are shared among different stakeholder groups. The subproject benefits will accrue primarily to government with the factory being a state-owned enterprise. An assessment of the distribution of benefits and costs is

presented in Table 32. The present value of the positive externality created by the subproject is Kip 1,250 million, of which Kip 859 million is realized by the government, and remaining Kip 391 million goes to the unskilled labor.

Table 32: Distribution Analysis – Biofertilizer Factory Subproject
(Kip million)

	FNPV	ENPV	Externality	Allocation of Externality	
				Government	Labor
Project benefits					
Sales revenue, net of VAT	17,229.7	17,229.7	0.0		
Change in AR	-97.4	-97.4	0.0		
Net resource inflow	17,132.3	17,132.3	0.0	0.0	0.0
Project costs					
Raw materials purchase costs	3,627.3	3,627.3	0.0		
O&M costs	7,254.6	6,245.3	-1,009.3	-646.6	-362.7
Capital costs	6,156.9	5,493.6	-663.2	-634.7	-28.5
Net VAT liability	-1,340.4	0.0	1,340.4	1,340.4	
Change in AP	-82.1	-82.1	0.0		
Change in CB	39.0	39.0	0.0		
Corporate income tax	943.8	0.0	-943.8	-943.8	
Prorated project management costs	21.3	47.5	26.2	26.2	
Net resource outflow	16,620.4	15,370.6	-1,249.8	-858.6	-391.2
Net resource flow	511.9	1,761.7	1,249.8	858.6	391.2

AP = accounts payable, AR = accounts receivable, CB = cash balance, ENPV = economic net present value, FNPV = financial net present value, O&M = operation and maintenance, VAT = value added tax.

Source: Consultants' estimates.

Appendix 1: Derivation of Shadow Exchange Rate Factor

1. The economic analysis uses a shadow exchange rate factor (SERF) of 1.029. The derivation is presented in the following tables:

Trade elasticity

Import	#	-1.37
Export	#	0.78

Source: IMF, A Method for Calculating Export Supply and Import Demand Elasticities, 2010

<http://www.imf.org/en/Publications/WP/Issues/2016/12/31/A-Method-for-Calculating-Export-Supply-and-Import-Demand-Elasticities-24117>

Table A1.1: Data

	Unit	2012	2013	2014	2015	2016	Average
Inflation	%	4.26%	6.37%	4.13%	1.28%	1.60%	3.53%
Exchange rate (A)	LAK/\$	8,007.3	7,835.4	8,045.5	8,131.2	8,125.9	8,029.1
Trade taxes							
Import duties (B1)	billion LAK	1,047	1,205	1,336	1,357	1,981	1,385
Export duties (B2)	billion LAK	105	92	321	230	69	163
Total (B=B1+B2)	billion LAK	1,152	1,297	1,658	1,586	2,050	1,549
Trade balance							
Import (C1)	\$ million	3,055	3,081	4,271	5,233	4,739	4,076
Export (C2)	\$ million	2,271	2,264	2,662	2,769	3,352	2,664
Total (C=C1+C2)	\$ million	5,326	5,345	6,933	8,002	8,092	6,739
Import (D1=C1/A)	billion LAK	24,463	24,140	34,364	42,549	38,512	32,806
Export (D2=C2/A)	billion LAK	18,182	17,739	21,417	22,515	27,239	21,419
Total (D=D1+D2)	billion LAK	42,645	41,879	55,782	65,064	65,752	54,224

Source: Bank of Lao PDR. 2016. *Annual Economic Report*. Vientiane.

https://www.bol.gov.la/together_use/Annual%20Report%202016_Eng.pdf

Table A1.2: Shadow Exchange Rate Factor Calculation

	Unit	2012	2013	2014	2015	2016	Average
Effective Tax rate							
Import (E1=B1/D1)	%	4.28%	4.99%	3.89%	3.19%	5.14%	4.30%
Export (E2=B2/D2)	%	0.58%	0.52%	1.50%	1.02%	0.25%	0.77%
Elasticity							
Import (F1)	#	-1.37	-1.37	-1.37	-1.37	-1.37	-1.37
Export (F2)	#	0.78	0.78	0.78	0.78	0.78	0.78
Weight							
Import (G1=-((F1*(C1/C2))/(F2-F1*(C1/C2)))	#	0.70	0.71	0.74	0.77	0.71	0.73
Export (G2=F2/(F2-F1*(C1/C2)))	#	0.30	0.29	0.26	0.23	0.29	0.27
Shadow exchange rate factor	#	1.028	1.034	1.025	1.022	1.036	1.029

Note: Formula follows ADB's Guidelines for the Economic Analysis of Projects, Table A12

Source: ADB. 2017. *Guidelines for the Economic Analysis of Projects*. Manila.

Appendix 2: Derivation of the Prorated Project Management Costs

1. The total cost of all activities under outputs 1 to 3 sum to \$35.29 million. Output 1.3 (agribusiness enterprise value chain infrastructure improved), Output 2.2 (capacity in climate smart agriculture strengthened), Output 3.2 (training of participating financial institutions) sum to \$14.46 million, which is equivalent to 41.0% of the total costs. Therefore, the amount of project management cost, totaling \$7.97 million, to be prorated is \$3.26 million (\$7.97 million*41.0%).

Table A2.1: Total Project Costs

Item	Unit	Financial Value							Economic value				total	CF				
		Base + Phy	Tax	net of tax	tradable	non-tradable	skilled	unskilled	tradable	non-tradable	skilled	unskilled						
Conversion factors													1.03	1.00	1.00	0.80		
A. Base Costs^b																		
1. Critical agribusiness value chain infrastructure improved and made climate resilient																		
1.1 Climate resilient communal rural infrastructure improved																		
Upgrading and rehabilitation of irrigation facilities	million USD	7.61	0.63	6.99	2.64	3.36	0.33	0.66		2.72	3.36	0.33	0.53	6.93	0.91			
Construction of water retention ponds	million USD	1.30	0.11	1.20	0.36	0.70	0.05	0.09		0.37	0.70	0.05	0.07	1.19	0.91			
Upgrading and rehabilitation of farm access roads	million USD	3.95	0.33	3.62	1.45	1.63	0.18	0.36		1.49	1.63	0.18	0.29	3.60	0.91			
1.2 Crop research, protection and testing infrastructure enhanced																		
Upgrading state rice & vegetable seed research centers	million USD	2.47	0.28	2.19	1.09	0.88	0.11	0.11		1.12	0.88	0.11	0.09	2.20	0.89			
Upgrading of diagnostic soil laboratories	million USD	0.73	0.09	0.64	0.16	0.48	0.00	0.00		0.17	0.48	0.00	0.00	0.65	0.89			
Upgrading of plant protection laboratories	million USD	0.58	0.06	0.52	0.13	0.39	0.00	0.00		0.13	0.39	0.00	0.00	0.52	0.90			
1.3 Agribusiness enterprise value chain infrastructure improved																		
Upgrading rice mill infrastructure with service provision to farmers	million USD	7.09	0.84	6.25	3.12	2.19	0.31	0.62		3.22	2.19	0.31	0.50	6.21	0.88			
Upgrading vegetable collection & marketing infrastructure with service prov	million USD	3.72	0.44	3.28	1.42	1.43	0.14	0.28		1.46	1.43	0.14	0.23	3.26	0.88			
Upgrading organic bio-fertilizer factories with service provisions to farmers	million USD	1.02	0.12	0.90	0.45	0.32	0.05	0.09		0.46	0.32	0.05	0.07	0.90	0.88			
Subtotal		28.48	2.90	25.58	10.83	11.36	1.17	2.22		11.15	11.36	1.17	1.78	25.46	0.89			
2. Climate-smart and organic agriculture promoted																		
2.1 Climate-resilient rice and vegetable varieties disseminated																		
New rice and vegetable varieties development and deployment	million USD	1.05	0.09	0.96	0.24	0.72	0.00	0.00		0.25	0.72	0.00	0.00	0.97	0.92			
2.2 Capacity in climate smart agriculture strengthened																		
Training of trainers (TOT)	million USD	0.16	0.01	0.14	0.04	0.11	0.00	0.00		0.04	0.11	0.00	0.00	0.14	0.92			
Training for farmers, APGs, enterprise owners, and research centers and I	million USD	2.31	0.20	2.11	0.53	1.58	0.00	0.00		0.54	1.58	0.00	0.00	2.13	0.92			
2.3 Smallholder refinancing scheme (SRS) operationalized																		
Provision of Smallholders' Refinancing Scheme (SRS) to APGs		1.28	0.00	1.28	0.32	0.96	0.00	0.00		0.33	0.96	0.00	0.00	1.28	1.01			
Subtotal		4.79	0.30	4.49	1.12	3.37	0.00	0.00		1.16	3.37	0.00	0.00	4.52	0.94			
3. Enabling environment for climate-friendly agribusiness enhanced																		
3.1 Climate Smart Agribusiness Policies and Standards																		
Policy development on agribusiness and PPCP	million USD	0.07	0.01	0.07	0.02	0.05	0.00	0.00		0.02	0.05	0.00	0.00	0.07	0.92			
Support and facilitation in securing standards and certifications	million USD	0.42	0.04	0.38	0.10	0.29	0.00	0.00		0.10	0.29	0.00	0.00	0.39	0.92			
Land registration and titling	million USD	0.60	0.05	0.55	0.14	0.41	0.00	0.00		0.14	0.41	0.00	0.00	0.55	0.92			
3.2 Green finance initiatives																		
Policy research and studies on green funding and credit mechanisms	million USD	0.23	0.02	0.21	0.05	0.16	0.00	0.00		0.05	0.16	0.00	0.00	0.21	0.92			
In-depth study and pilot project on crop insurance	million USD	0.53	0.05	0.48	0.12	0.36	0.00	0.00		0.12	0.36	0.00	0.00	0.48	0.92			
Training for FIs	million USD	0.17	0.01	0.15	0.04	0.12	0.00	0.00		0.04	0.12	0.00	0.00	0.15	0.92			
Subtotal		2.02	0.17	1.84	0.46	1.38	0.00	0.00		0.47	1.38	0.00	0.00	1.86	0.92			
4. Project management and support																		
Project staffing and consultancy	million USD	6.65	0.52	6.13	0.36	3.59	1.52	0.00		0.37	3.59	1.52	0.00	5.48	0.82			
Project staff training	million USD	0.02	0.00	0.02	0.00	0.02	0.00	0.00		0.00	0.02	0.00	0.00	0.02	0.92			
Project administration and operating expenses	million USD	1.30	0.15	1.15	0.19	0.96	0.00	0.00		0.19	0.96	0.00	0.00	1.16	0.89			
Subtotal		7.97	0.67	7.30	0.55	4.57	1.52	0.00		0.56	4.57	1.52	0.00	6.65	0.83			
Subtotal (A)		43.26	4.05	39.21	12.96	20.68	2.68	2.22		13.35	20.68	2.68	1.78	38.49	0.89			

Table A2.2: Prorated Project Management and Associated Costs per \$ on Output 1.3

	Fin. price	Tax	Fin. price (net of tax)	Decomposition			Econ. Price	CF	
				Tradable	Non- Skilled	Unskilled			
Conversion factors				1.03	1.00	1.00	0.80		
Output 1.3 Agribusiness enterprise value chain infrastructure improved (A)	11.83	1.40	10.43	5.15	3.93	0.50	0.80	10.38	
Output 2.2 Capacity in climate smart agriculture strengthened (B)									
Training of trainers (TOT)	0.16	0.01	0.14	0.04	0.11	0.00	0.00	0.14	
Training for farmers, APGs, enterprise owners, and research centers and laboratory staff	2.31	0.20	2.11	0.54	1.58	0.00	0.00	2.13	
Output 3.2 Green finance initiatives (C)									
Training for FIs	0.17	0.01	0.15	0.04	0.12	0.00	0.00	1.28	
Project management and support (D)									
Project staffing and consultancy ^a	2.73	0.25	2.46	0.17	1.28	0.65	0.00	2.20	
Project staff training	0.01	0.00	0.01	0.00	0.01	0.00	0.00	0.01	
Project administration and operating expenses	0.53	0.07	0.46	0.09	0.34	0.00	0.00	0.46	
Total project costs to be prorated to sample subproject (E=B+C+D)	5.90	0.55	5.34	0.87	3.43	0.65	0.00	6.23	
Prorated PM per dollar of direct investment cost (F=E/A)									
USD	0.4990								
LAK (8100 Kip/\$)	4042.15	2235.44	1806.71	1626.99	6202.04	1176.64	0.00	9005.67	2.23

Source: Consultant's estimates.

Appendix 3: Civil Work and Equipment Operations and Maintenance Cost Estimates by Project Sub-Outputs

1. There are three types of infrastructure maintenance for public infrastructure investments: (i) routine or preventive maintenance is required on a regular basis to keep the infrastructure in good working condition. If performed correctly and regularly, it can reduce the need for periodic maintenance, and sustain the life of the infrastructure; (ii) periodic maintenance covers more significant activities that are carried out once every few years. Periodic maintenance is generally technically complex and costly, and require resources, specialized equipment and skills beyond the command of beneficiary communities; and (iii) emergency maintenance involves urgently needed, and generally significant, repairs in response to disastrous event. Emergency maintenance is not considered in this discussion.

2. The analyzed sample subprojects fall under output 1.3 (agribusiness enterprise value chain infrastructure improved). Since these are all revenue-generating subprojects, and subprojects benefits can be internalized, the subproject beneficiaries will take responsibility for periodic and routine operations and maintenance (O&M). The analysis indicates that sample subprojects will generate sufficient net operating income for O&M and debt servicing.

3. For other proposed civil work investments under output 1.1 (crop research, protection and testing infrastructure enhanced) and output 1.2 (crop research, protection and testing infrastructure enhanced), these are considered public goods and are not revenue-generating. Farmer groups are expected to perform routine O&M. Farmer groups are expected to collect limited fees from members for routine O&M. In addition, the project will train and strengthen farmer groups capacity on O&M planning and execution. The O&M plans will clearly define the roles and responsibilities of different stakeholders, include a schedule of routine maintenance activities, initial user tariffs (wherever applicable), and collection mechanisms, as well as estimated O&M costs for the lifespan of the infrastructure. Readiness and commitment to assume routine O&M responsibility is a site selection criterion for these public infrastructure subprojects.

4. As for periodic O&M, this is primarily the government's responsibility. At project completion, about \$17.95 million will be spent on public infrastructure under outputs 1.1 and 1.2. The total annual O&M budgetary support required for O&M is estimated to be around \$0.64 million (Table A3.1) at project completion (2023 or 2024). About 50% of the budget requirement is for irrigation schemes and water retention ponds, estimated to be \$0.39 million. As compared against the average government's annual budget of \$24.6 million on public water resources infrastructure (Table A3.2), the \$0.39 million equivalent is insignificant and should not create excessive fiscal burden at project completion.¹

¹ In recent years, O&M budget has been decreasing since 2013, from \$37.9 million to \$15.1 million, owing to fiscal contraction necessitated by persistent current account deficit, falling foreign currency reserves, and growing public debt. The trend however is not expected to continue until project completion when governmental budgetary subproject for O&M will be required.

Table A3.1: Civil Work and Equipment Maintenance Cost Estimates by Project Sub-Outputs

	Project investment ^a _b (\$ million)	O&M requirement (%)	O&M requirement (\$ million)	O&M responsibility	Budgetary support (\$ million)
Output 1.1 Climate-resilient communal rural infrastructure improved					
Upgrading and rehabilitation of irrigation facilities	8.19	4.0%	0.33	DOI & farmers	0.33
Construction of water retention ponds	1.42	4.0%	0.06	DOI	0.06
Upgrading and rehabilitation of farm access roads	4.27	4.0%	0.17	DOI	0.17
Output 1.2 Crop research, protection and testing infrastructure enhanced					
Upgrading state rice & vegetable seed research centers	2.67	2.0%	0.05	NAFRI	0.05
Upgrading of diagnostic soil laboratories	0.78	2.0%	0.02	DALAM	0.02
Upgrading of plant protection laboratories	0.62	2.0%	0.01	DOA	0.01
Output 1.3 Agribusiness enterprise value chain infrastructure improved					
Upgrading rice mill infrastructure with service provision to farmers	7.46	3.0%	0.22	Rice mills	0.00
Upgrading vegetable collection & marketing infrastructure with service provision to farmers	3.92	3.0%	0.12	APGs & agri-businesses	0.00
Upgrading organic biofertilizer factories with service provisions to farmers	1.08	3.0%	0.03	Biofertilizer factories	0.00
Total	30.41				0.64

APG = agricultural producer group, DOA = Department of Agriculture, DOI = Department of Irrigation, DALAM = Department of Agricultural Land Management, NAFRI = National Agricultural and Forestry Research Institute, O&M = operations and maintenance.

Note: Figures may not sum due to rounding.

^a Inclusive of physical and price contingencies.

^b Cost figures include only civil work and equipment, not other expenditure categories such as training, supplies and materials, training, project management costs, etc.

Source: ADB estimates.

Table A3.2: Operations and Maintenance Budget Allocation for Public Water Resources Infrastructure

Year	Number of Scheme	Average budget per Scheme (million Kip)			Exchange rate ^a (Kip/\$)	Total budget (\$ million)
		Headwork	Main and sub-cannel	Total budget		
2013-2014	446	115,814	188,141	303,955	8019.5	37.9
2014-2015	436	52,168	152,229	204,397	8095.0	25.2
2015-2016	532	92,081	175,702	267,783	8146.0	32.9
2016-2017	244	33,016	64,813	97,828	8167.8	12.0
2017-2018	346	50,274	75,622	125,897	8317.5	15.1
Average	390	68,671	131,301	199,972		24.6

^a As of end of year (December 31).

Source: Division of Management and Operation, Department of Irrigation.