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Financial Feasibility of Cajuput Plantation Forest Business in the Yogyakarta Forest Management Unit, Indonesia

Kelayakan Finansial Bisnis Hutan Tanaman Kayu Putih di Kesatuan Pengelolaan Hutan (KPH) Yogyakarta, Indonesia

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ABSTRACT

The forestry sector makes a significant contribution to Indonesia's national economy, including through non-timber forest products (NTFPs), such as Cajuput oil. The Yogyakarta Forest Management Unit (FMU) manages the Sendang Mole Cajuput plantation forest and the oil factory. This research aimed to analyze the production costs, business feasibility, and sensitivity to changes in market conditions that may affect the company's viability. Data were collected through interviews, observations, and financial documents from 2018 to 2022. Financial feasibility indicators include profit, Cost-to-Income Ratio (CIR), Return on Investment (ROI), and sensitivity to changes in yields and raw material prices. The results showed an average annual profit of IDR 610,863,515, an Income Ratio of 88.36%, and an ROI of 13.18%. These indicated the business was financially viable and profitable. Sensitivity analysis demonstrated that the business was highly sensitive to cajuput oil selling price reductions, becoming unfeasible at IDR 190,100/L and reaching break-even at IDR 212,408/L, while remaining feasible under a 10% decline in the yield and a 20% increase in raw material costs.

INTISARI

KATA KUNCI

kelayakan finansial, ekonomi kehutanan, bisnis kehutanan, analisis sensitivitas, hutan tanaman kayu putih

Sektor kehutanan memberikan kontribusi signifikan terhadap perekonomian nasional Indonesia, termasuk melalui hasil hutan bukan kayu (HHBK) seperti minyak kayu putih. Kesatuan Pengelolaan Hutan (KPH) Yogyakarta mengelola hutan tanaman kayu putih dan Pabrik Minyak Kayu Putih (PMKP) Sendang Mole sebagai bentuk praktik bisnis berbasis HHBK. Penelitian ini menganalisis biaya produksi, kelayakan usaha, dan sensitivitas terhadap perubahan kondisi pasar yang dapat memengaruhi keberlanjutan usaha. Pengumpulan data pada penelitian ini dilakukan melalui wawancara, observasi, dan analisis dokumen keuangan dari tahun 2018 hingga 2022. Indikator kelayakan finansial meliputi laba, rasio biaya terhadap pendapatan atau Cost-to-Income Ratio (CIR), pengembalian investasi atau Return on Investment (ROI), serta sensitivitas terhadap perubahan rendemen dan harga bahan baku. Hasil penelitian menunjukkan laba tahunan rata-rata sebesar Rp610.863.515, CIR sebesar 88,36%, dan ROI sebesar 13,18%. Hal ini menunjukkan bahwa usaha ini layak dan menguntungkan. Analisis sensitivitas menunjukkan bahwa bisnis ini sangat sensitif terhadap penurunan harga jual minyak kayu putih, sehingga bisnis ini menjadi tidak layak secara finansial pada harga jual Rp190.100/L dan mencapai titik impas pada harga Rp212.408/L, namun tetap layak secara finansial meskipun terjadi penurunan hasil panen sebesar 10% dan kenaikan biaya bahan baku sebesar 20%.

Introduction

Indonesia is rich in natural resources, with the forestry sector playing a crucial role in the national economy. As renewable resources, forests continuously evolve, offering substantial potential for supply while ensuring environmental sustainability. Forest management and utilization must be optimized and conducted sustainably to maximize the benefits of both timber and non-timber forest products (NTFPs). In general, NTFPs, consisting of biological materials derived from flora and fauna, are widely used by communities for direct consumption, including food, medicine, and firewood (Hutagaol & Rostika 2022). By promoting sustainable practices, the forestry sector can enhance economic opportunities while preserving ecosystems, ensuring that forest resources remain available for future generations.

NTFPs can be classified into several categories, including structural and extractive plants, as well as cultivated and minor products (Lekitoo & Khayati 2019). One of the essential products from the extractive plant category is essential oil, including cajuput (*Melaleuca leucadendron*). This oil is produced by distilling of leaves and twigs of the cajuput tree, with the main compound being 1,8-cineole ($C_{10}H_{18}O$), which has various medical and pharmaceutical benefits (Mumtazy et al. 2021). The quality standard for cajuput oil is regulated by Indonesia's National Standard (SNI) 3954:2014, which requires a 1,8-cineole content of 55-60% for the highest quality category. Moreover, cajuput oil has promising business prospects as it is in demand across various industries, including food and pharmaceuticals (Rahayu & Laraswati 2021).

Demand for cajuput oil continues to grow alongside with the development of the global pharmaceutical, cosmetic, and aromatherapy industries. The global essential oil demand reaches about 120,000 t annually, with cajuput accounting for about 15% of the total demand. In the context of international trade, Indonesia still imports certain essential oils to meet the needs of the domestic industry (Putra et al. 2024). In contrast, cajuput oil exports have fluctuated in the last five years. Data from Pasaribu et al. (2021) showed that Indonesia's cajuput oil exports reached 4,500 t in 2020, while imports of other essential oils increased by

10% during the same period. With abundant resource potential, optimizing cajuput oil production can be a strategic opportunity to reduce import dependence and increase competitiveness in the global market.

The cajuput plant has several advantages, such as rapid growth, tolerance to harsh environmental conditions, and resistance to fire (Mustika et al. 2022). The cajuput oil processing industry is relatively profitable due to minimal competition and a broad market. Additionally, this industry creates employment opportunities for local communities (Nurlatu et al. 2019). One of the cajuput oil processing factories in Indonesia is the Sendang Mole Cajuput Oil Factory, managed by the Yogyakarta Forest Management Unit (FMU) under the Yogyakarta Environment and Forestry Agency. This factory has a production capacity of 18 t of leaves/day, with an average annual production of 42,310 L, equivalent to IDR 10,154,400,000 in 2021 (Balai Kesatuan Pengelolaan Hutan 2021; Biro Umum Humas dan Protokol DIY 2021).

Although the cajuput oil industry has considerable potential to respond to increasing global demand, research on its economic and financial performance remains limited. Previous research has predominantly emphasized production and refining aspects, leaving the issue of profitability insufficiently explored (Arias et al. 2023). Furthermore, existing research has mainly addressed technical dimensions, including land suitability and silvicultural strategies affecting plant growth and yield (Sadono et al. 2019), stand productivity and biomass development across age classes (Prasditio et al. 2025), and breeding-related traits, namely leaf biomass and oil concentration that determine oil yield and economic value (Kartikawati et al. 2021). Despite these contributions, the literature continues to focus more on productivity improvement than on comprehensive assessments of financial feasibility, indicating a persistent gap in understanding the profitability of the cajuput oil industry.

The existing research still shows important methodological limitations. The majority rely on discounted cash flow indicators such as Net Present Value (NPV), Internal Rate of Return (IRR), and Benefit-Cost Ratio (BCR), which are more appropriate for evaluating investment feasibility than daily operational performance. Profitability assessments

also tend to be static and confined to single-period analysis, reducing the capacity to capture financial dynamics over time. This limitation is particularly important given that profitability research in the cajuput oil industry remains scarce relative to the market potential (Arias et al. 2023). At the same time, the sector contribution to community income suggests that profitability should be evaluated more carefully under changing production capacity and resource conditions (Assagaf et al. 2020). Empirical research further indicates that feasibility outcomes may vary depending on the indicators applied, reflecting inconsistencies in assessment approaches (Mahmudah et al. 2024). In addition, structural pressures such as price fluctuations, low productivity, and competition from imported eucalyptus oil further constrain business performance and profitability (Rochman et al. 2024). Broader sustainability requirements also suggest that long-term business viability depends on the integration of economic, social, and environmental considerations (Ermawati et al. 2021).

Based on the existing gaps, this research proposes a more comprehensive and operational framework for evaluating the financial viability of the Cajuput oil business. It examines production costs, business profitability with the Cost-to-Income Ratio (CIR) and Return on Investment (ROI), and sensitivity to changes in market conditions that may affect the company's viability. This approach enables a more robust assessment of cost efficiency, revenue perfor-

mance, and financial sustainability over time. The results contribute to the literature in three main respects. First, by introducing CIR as an operational efficiency indicator that has rarely been applied in the cajuput oil industry. Second, this research used multi-year financial data to capture the temporal dynamics of profitability, rather than relying on a single-period evaluation. Third, it incorporated sensitivity analysis to examine the responsiveness of profitability to changes in key variables affecting business performance. By integrating these analytical dimensions, this research offers a more comprehensive and practically relevant basis for financial evaluation and managerial decision-making in the cajuput oil industry.

Methods

Location and Time

This research was conducted at the Cajuput plantation and Sendang Mole Cajuput Oil Mill managed by the Yogyakarta FMU. This research was carried out from March to May 2023. Cajuput plantation specifically supplies Sendang Mole Cajuput Oil Mill. The Cajuput plantation covers an area of 2,234 ha and is managed across four sections: Playen, Paliyan, Panggang, and Karangmojo. The location of these four forest sections and the Cajuput oil mill are presented in Figure 1. Cajuput leaves can be harvested when the stands reach approximately three

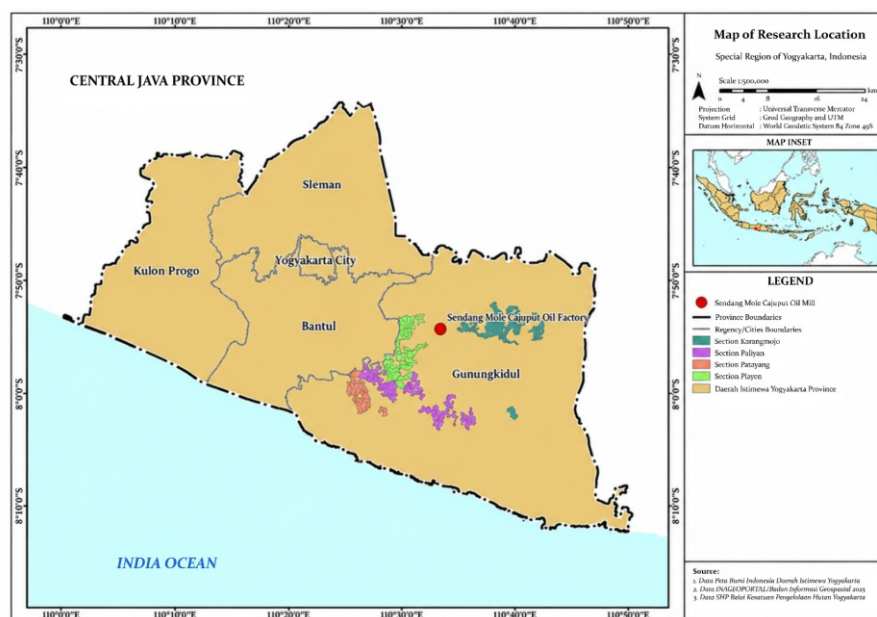


Figure 1. Sendang Mole Cajuput Oil Factory and Cajuput Plantation in Yogyakarta Forest Management Unit (FMU)

years of age, while stand rejuvenation is generally conducted at approximately 40 years of age to maintain productivity. Meanwhile, the Cajuput mill in Playen (Figure 1) is recognized as the largest Cajuput oil mill in Yogyakarta. The mill is capable of processing 18 t leaves/day.

Data Collection

This research used both primary and secondary data to analyze the financial and operational performance of cajuput oil production at PMKP Sendang Mole. The researchers collected primary data through direct interviews and field observations, while secondary data originated from institutional reports, financial records, and relevant literature. The types, sources, and collection methods of data are summarized in Tables 1 and 2.

Data Analysis

Analysis of Cajuput Leaf Production Costs

The analysis of cajuput leaf production costs started with an assessment of the costs associated with cajuput plantation. This included fixed, direct, and routine investment costs. Fixed investment costs refer to expenses that are not affected by the volume of the plantation work, such as building, road, bridge, vehicle, office equipment, and other necessary procurement. Direct investment costs are expenses that depend on the volume of plantation work, such as land preparation, planting, maintenance, and harvesting. Routine investment costs refer to expenses that must be incurred periodically to maintain the quality, performance, and sustainability of the

investment, such as salaries, administrative services, facilities, and other costs. These costs were summed, yielding the total cost for the entire cycle. In this context, the cycle of cajuput plantation production spanned 40 years. The total cost over the production cycle was calculated by summing the fixed investment costs, direct investment costs, and routine investment costs. The total cost was then divided by the total cajuput leaf production over the cycle to estimate the Cost of Goods Sold (COGS) of cajuput leaves, as expressed in Equations 1 and 2.

$$TC = FIC + DIC + RIC \dots\dots\dots \text{Equation 1}$$

$$COGS = TC/Q \dots\dots\dots \text{Equation 2}$$

Remarks: TC = total cost of cajuput leaf production (IDR); FIC = fixed investment costs (IDR); DIC = direct investment costs (IDR); RIC = routine investment costs (IDR); COGS = Cost of Goods Sold of cajuput leaves (IDR/kg); and Q = total cajuput leaf production over the production cycle (kg).

Analysis of Cajuput Oil Production Costs

A cost analysis of cajuput oil production determined the total costs required to distill cajuput leaves into oil. This comprised fixed and variable costs. Fixed costs are expenses that do not vary with changes in a company's production volume, such as buildings in the factory area, factory production equipment, Personal Protective Equipment (PPE) and support, office inventory, employee salaries, insurance, administrative costs, telephone costs, and factory maintenance costs. Variable costs are attributable to fluctuations in each

Table 1. Primary data and collection methods

Data Type	Description	Source	Method
Factory profile	Organizational and operational characteristics	PMKP management	Interview
Production process	Processing stages and operational flow	PMKP staff	Observation, interview
Production capacity	Output volume (leaves and oil)	Mill productivity reports	Interview
Cost structure	Operational and production costs	PMKP management	Interview
Pricing strategy	Selling price and market distribution	PMKP management	Interview

Table 2. Secondary data and sources

Data Type	Description	Source
Plantation data	Area, cycle, and productivity	Yogyakarta Forest Management Unit reports
Investment data	Capital and fixed costs	PMKP financial records
Production data	Output data (2018–2022)	PMKP reports
Revenue data	Sales and income records	PMKP financial records
Cost data	Historical operational costs	PMKP financial reports
Yield data	Oil extraction efficiency	PMKP reports
Supporting literature	Theoretical and empirical references	Journals and publications

company's production volume or production activities, such as electricity, leaf cooking, ignition, briquette making, vaseline, lubricant, cation resin, cajuput oil weighing, cajuput oil transportation, overtime, food and drink costs, and fuel oil costs. Both fixed and variable costs were summed to obtain the total cost of the entire cycle. In this context, the cajuput oil factory's cycle spanned five years. The total production cost over the cycle was calculated by summing the fixed costs and variable costs. The total cost was then divided by the total cajuput oil production during the same period to calculate the COGS of cajuput oil, as expressed in Equations 3 and 4.

$$TC_o = FC + VC \dots\dots\dots \text{Equation 3}$$

$$COGS = TC_o / Q_o \dots\dots\dots \text{Equation 4}$$

Remarks: TC_o = total cost of cajuput oil production over the five-year cycle (IDR); FC = fixed costs (IDR); VC = variable costs (IDR); $COGS_o$ = Cost of Goods Sold of cajuput oil (IDR/L); and Q_o = total cajuput oil production over the five-year cycle (L).

Revenue Analysis

Revenue analysis aimed to estimate the income generated from product sales. In this research, revenue from Cajuput distillation was generated from selling Cajuput oil through an auction system. The revenue of PMKP Sendang Mole was calculated by multiplying the Cajuput oil production by the per-liter auction price. The price per-liter was determined based on the highest accepted bid in the auction, as expressed in Equation 5.

$$TR = Q_o \times P_o \dots\dots\dots \text{Equation 5}$$

Remarks: TR = total revenue from cajuput oil sales (IDR); Q_o = total cajuput oil production (L); and P_o = the highest accepted auction price of cajuput oil (IDR/L).

Business Feasibility Analysis

The financial feasibility analysis used a discounted cash flow approach based on financial realization data from the 2018–2022 period. The analysis linked revenue and cost components within a five-year cash flow framework, applying a 6.16% discount factor to

account for the time value of money. The discount rate represented the average real interest rate over the previous ten years, from 2013 to 2022. The annual real interest rate was calculated as the difference between the lending interest rate and the inflation rate for each year, and the resulting values were subsequently averaged. This approach enabled a more accurate assessment of financial performance by reflecting actual operational conditions over time. To evaluate the financial performance of the cajuput oil business, several key indicators were employed, namely Profit, CIR, and ROI.

Profit represents the difference between total revenue and total cost within a given period. Higher profit values indicate better and more sustainable business performance (Indrayani & Edwin 2021). The formula is expressed as Equation 6.

$$\pi = TR - TC \dots\dots\dots \text{Equation 6}$$

Remarks: π = profit (IDR); TR = total revenue (IDR); and TC = total cost (IDR).

When $\pi > 0$, then the project is considered profitable to run. However, when $\pi \leq 0$, the project is considered unprofitable.

CIR is the value of the comparison between total costs (TC) and revenue (TR). A lower ratio indicates that the company generates more income than it incurs in costs (Antwi 2019). The formula for CIR is expressed in Equation 7.

$$CIR = TC/TR \times 100\% \dots\dots\dots \text{Equation 7}$$

Remarks: CIR = Cost-to-Income Ratio (%); TC = total cost (IDR); and TR = total revenue (IDR).

The project is financially viable when the CIR value is $< 100\%$. A CIR value of 100% indicates the project is at the break-even point (BEP), and when $CIR > 100\%$, the project is not financially feasible.

ROI was used to measure the level of return generated from the capital invested. It reflects how effectively the investment is used to generate profit. The higher the ROI value, the more efficient the investment (Patrocínio et al. 2024). The ROI formula is expressed in Equation 8.

$$ROI = (TR - TC) / TC \times 100\% \dots\dots\dots \text{Equation 8}$$

Remarks: ROI = Return on Investment (%); TR = total revenue (IDR); and TC = total cost (IDR).

A project is considered financially viable if $ROI > 0$, while $ROI \leq 0$ indicates that the investment is not profitable.

Sensitivity Analysis

A business project is inherently exposed to uncertainty in several key input variables, including production costs, raw material prices, equipment costs, and sales volume. Therefore, incorporating uncertainty into financial evaluation is essential for improving the reliability of decision-making. In the context of cajuput oil distillation, a financial feasibility assessment commonly includes sensitivity analysis of variables such as revenue, fixed and variable costs, selling price/unit, and productivity (Mahmudah et al. 2024). Sensitivity analysis is applied to evaluate how changes in selected input variables may affect business performance and financial viability. In this research, sensitivity analysis was used to assess the

extent to which adverse changes, particularly in selling price, could be tolerated while maintaining the feasibility of the cajuput oil processing business at PMKP Sendang Mole.

Result and Discussion

Cajuput Leaf Production Costs

The total cost of acquiring fixed investments amounts to IDR 11,943,876,390. This includes costs for building procurement, road and bridge construction, installation and network, vehicle procurement, and general office equipment procurement. The highest cost refers to road and bridge construction, which reaches IDR 7,172,371,843. The detailed breakdown of the costs is presented in Table 3.

The cost of acquiring direct investments amounts to IDR 70,919,595,000 over the production cycle. The cost covers land preparation, planting, maintenance, leaf harvesting, and transportation. The highest cost is for leaf harvesting, at IDR 25,284,690,000 over the cycle. The details of the costs are provided in Table 4.

The routine cost components include employee

Table 3. Fixed investment costs

No.	Fixed Investment Cost Component	Unit Cost (IDR/Time)	Year	Frequency (Time(s))	Total Cost Over Cycle (IDR)
1	Building Procurement	1,563,659,634	0, 20	2	3,127,319,267
2	Road and Bridge Construction	3,586,185,922	0, 20	2	7,172,371,843
3	Installation and Network	19,773,448	0, 10, 20, 30	4	79,093,792
4	Vehicle Procurement	92,735,012	0, 10, 20, 30	4	370,940,048
5	General Office Equipment Procurement	149,268,930	0, 5, 10, 15, 20, 25, 30, 35	8	1,194,151,440
Total Fixed Investment Costs Over Cycle					11,943,876,390

Table 4. Direct investment costs

No.	Direct Investment Cost Component	Unit Cost (IDR/Time)	Year	Frequency (Time(s))	Total Cost Over Cycle (IDR)
1	Land Preparation	13,448,680,000	0	1	13,448,680,000
2	Planting	10,598,096,000	1	1	10,598,096,000
3	Maintenance I	4,655,656,000	2	1	4,655,656,000
4	Maintenance II	2,417,188,000	3	1	2,417,188,000
5	Leaf Harvesting	683,370,000	4-40	37	25,284,690,000
6	Leaf Transportation	392,305,000	4-40	37	14,515,285,000
Total Direct Investment Costs Over Cycle					70,919,595,000

Table 5. Routine investment costs

No.	Routine Investment Cost Component	Unit Cost (IDR/Time)	Year	Frequency (Time(s))	Total Cost Over Cycle (IDR)
1	Employee Salaries	724,275,695	Annually	40	28,971,027,800
2	Office Administration Services	31,098,553	Annually	40	1,243,942,120
3	Maintenance of Facilities and Infrastructure	40,731,839	Annually	40	1,629,273,560
4	Forest and Land Rehabilitation	21,708,493	Annually	40	868,339,720
5	Forest Resource Protection and Conservation	3,750,682	Annually	40	150,027,280
Total Routine Investment Costs Over Cycle					32,862,610,480

salaries, office administration, maintenance of facilities and infrastructure, forest and land rehabilitation, and protection and conservation of forest resources. The cost estimate is IDR 32,862,610,480 over the cycle, with the largest component being employee salaries at IDR 28,971,027,800. The summary of routine costs is presented in Table 5.

According to the above analysis, the total costs of fixed, direct, and routine investment over the cycle were determined to be IDR 119,064,188,870. On the other hand, data from the Yogyakarta FMU show that total Cajuput leaf production over the cycle is 93,647,000 kg. Therefore, the COGS of the Cajuput leaf is IDR 1,271.41/kg. The details of Cajuput leaf production costs, or raw material procurement costs for Cajuput oil production, are presented in Table 6.

The COGS of Cajuput leaf at PMKP Sendang Mole, at IDR 1,271.41/kg, can be classified as relatively high. Mahmudah et al. (2024) reported that producing 1 kg of Cajuput oil requires approximately 100–180 kg of Cajuput leaves, so the estimated raw material cost/kg of Cajuput oil is IDR 127,141–228,854. This range is above the normal cost rate, ranging from IDR 75,400–172,476/kg. This becomes a critical issue because the domestic Cajuput oil business faces competitive pressure from imported Eucalyptus oil sold at a much lower price. Furthermore, Prasdito et al. (2025) also showed that Cajuput productivity is strongly affected by stand age and site conditions, with optimal productivity at 17-year-old stands and a 40%

productivity decline at 21-year-old stands. At PMKP Sendang Mole, the ages of the cajuput stand vary among forest management sections, ranging from approximately 3 to 40 years. Stands reaching approximately 40 years of age are classified as overmature and are gradually rejuvenated to maintain leaf productivity and the continuity of raw material supply. Therefore, variations in stand age and suboptimal leaf productivity may place even greater pressure on production efficiency and profitability, particularly at a leaf COGS of IDR 1,271.41/kg.

Cajuput Oil Production Costs

At PMKP Sendang Mole, fixed costs include expenditures for building procurement within the factory area, machinery and processing equipment, personal protective equipment and supporting tools, office inventory, administrative expenses, telephone costs, factory maintenance, and employee salaries. The total of these costs is IDR 960,613,442/year, or IDR 4,803,067,210 over five years (the entire production). The highest cost remains employee salaries, totaling IDR 348,796,800/year, or IDR 1,743,984,000 over five years. A summary of these fixed cost components is presented in Table 7.

Meanwhile, variable costs include components such as raw materials, electricity, ignition, cooking, briquette production, generator fuel, lubricants, vaseline, cation resin, measuring, Cajuput oil transportation, and meal allowances. The total variable cost is

Table 6. Cajuput leaf production costs

No.	Cost Type	Total Cost Over Cycle (IDR)
1	Fixed Investment Costs	11,943,876,390
2	Direct Investment Costs	70,919,595,000
3	Routine Investment Costs	36,200,717,480
Total Cost Over Cycle (IDR)		119,064,188,870
Total Cajuput Leaf Production Over Cycle (Kg)		93,647,000
COGS of Cajuput Leaf (IDR/Kg)		1,271.41

Table 7. Fixed costs of PMKP Sendang Mole

No.	Fixed Investment Cost Component	Total Cost (IDR)	Lifetime (Year)	Depreciation in a year (IDR)	Depreciation Over the Cycle (IDR)
1	Factory Building Procurement Costs	2,958,764,750	20	147,938,238	739,691,190
2	Cajuput Oil Processing Machine	8,664,971,862	35	247,570,625	1,237,853,125
3	Factory Equipment Procurement Costs	482,254,000	10	48,225,400	241,127,000
4	PPE and Supporting Tools Costs	38,234,900	5	7,646,980	38,234,900
5	Factory Inventory Costs	58,367,000	5	11,673,400	58,367,000
6	Administrative Costs	29,442,000	1	29,442,000	147,210,000
7	Employee Salaries	348,796,800	1	348,796,800	1,743,984,000
8	Maintenance Costs	119,320,000	1	119,320,000	596,600,000
Total Fixed Costs				960,613,442	4,803,067,210

IDR 18,379,328,712 over the five years. Cajuput leaf procurement cost is the highest among all expenses, totaling IDR 14,847,584,370 over the cycle. The recap of these variable costs is presented in Table 8.

Table 8. Variable costs of PMKP Sendang Mole

No.	Variable Cost Components	Total Cost Over the Cycle (IDR)
1	Cajuput Leaf Procurement Costs	14,847,584,370
2	Briquette Production Costs	326,984,000
3	Cooking Costs	1,459,750,000
4	Ignition Costs	1,167,800,000
5	Factory Fuel Costs	157,524,542
6	Lubricant Costs	3,281,518
7	Cation Resin and Salt Costs	169,798,120
8	Vaseline Costs	31,682,414
9	Measuring Costs	27,285,250
10	Cajuput Oil Transportation Costs	87,312,800
11	Worker Overtime Pay	67,627,298
12	Electricity Costs	32,698,400
	Total Variable Costs	18,379,328,712

According to the analysis, the total of fixed and variable costs was determined at IDR 23,182,395,923 over the cycle. On the other hand, PMKP Sendang produced 109,141 L of Cajuput oil over the cycle. Hence, the production costs for generating Cajuput oil resulted in a calculated COGS of IDR 212,408/L. The breakdown of production costs for Cajuput oil is presented in Table 9.

The COGS of Cajuput oil at IDR 212,408/L is relatively high, though it may still be financially acceptable within an integrated plantation–processing business model. This classification is based on Rochman et al. (2024), who reported that Perum Perhutani's cajuput oil sales in 2020–2022 reached

715,113 kg with total revenue of IDR 208.93 billion. This estimates an average sales realization of approximately IDR 292,000/kg. The COGS of IDR 212,408/L leaves a relatively narrow margin, especially amid competition from imported Eucalyptus oil sold at much lower prices. However, Ermawati et al. (2021) found that the development of the Cajuput oil business can remain feasible when managed in an integrated system. Thus, the COGS of IDR 212,408/L remains feasible, but the business should be better managed and supported by integrated upstream–downstream efficiency, stable productivity, and premium market positioning.

Revenue Analysis

Table 10 shows that the revenue of PMKP Sendang Mole over the last five years, from 2018 to 2022, amounted to IDR 26,236,713,500. The average annual revenue was IDR 5,247,342,700, calculated by multiplying the output of Cajuput oil production by the auction selling price. Over the past five years, the lowest Cajuput oil price was in 2018, at IDR 190,100/L, while the highest was in 2021, at IDR 270,700/L. The increase in Cajuput oil price in 2021 reflected the rising global demand for essential oils as raw materials for the pharmaceutical and aromatherapy industries (Anjum et al. 2024).

Although the production of essential oils, including Cajuput, is subject to market price fluctuations due to a mismatch between production and demand that depends on uncontrollable weather, price adjustments often help stabilize revenue streams

Table 9. Cajuput oil production costs

No.	Cost Type	Total Cost Over the Cycle (IDR)
1	Fixed Costs	4,803,067,211
2	Variable Costs	18,379,328,712
	Total Costs Over the Cycle (IDR)	23,182,395,923
	Total Cajuput Oil Production Over the Cycle (L)	109,141
	COGS Cajuput Oil (IDR/L)	212,408

Table 10. Revenue of PMKP Sendang Mole

Year	Production Output (L)	Price/L (IDR)	Total Revenue (IDR)
2018	22,692	190,100	4,313,749,200
2019	22,821	224,300	5,118,750,300
2020	21,148	258,500	5,466,758,000
2021	22,245	270,700	6,021,721,500
2022	20,235	262,700	5,315,734,500
		Total Revenue in five Years (IDR)	26,236,713,500
		Average Annual Revenue (IDR)	5,247,342,700

for companies. This is in line with the results of Hanif et al. (2024), who stated that dependence on selling prices causes the variability of essential oil producers' income to be more influenced by market dynamics than the production volume.

Based on the data, it is evident that the higher the selling price of cajuput oil in a given year, the greater the revenue earned by the factory in producing the products. Compared with other years, 2021 had the highest Cajuput oil revenues. The total revenue from Cajuput oil sales in 2021 was IDR 6,021,721,500. Although the Cajuput oil production in 2021 was lower than in 2018 and 2019, the revenue was higher due to the high selling price of the product in 2021. The selling price of essential oils, including eucalyptus oil, directly impacts industry revenue. Although production falls, price increases can compensate and even raise total revenue. These prices fluctuate depending on raw material availability, production costs, market demand, harvesting season, and product quality and authenticity (Hanif et al. 2024).

Business Feasibility Analysis

Based on calculations, using a discounted cash flow approach with a discount rate of 6.16%, the total cost of Cajuput oil production over the past five years at PMKP Sendang Mole was IDR 23,182,395,923, generating a total revenue of IDR 26,236,713,500. From these results, the value for profit was IDR 3,054,317,573, or an average annual profit of IDR 610,863,515. CIR and ROI were obtained at 88.36% and 13.18%, respectively (Table 11). This indicates that the production of cajuput oil is financially feasible for further development.

Table 11. Financial feasibility analysis of Sendang Mole PMKP

Financial Feasibility Component	Value
Total Cost	IDR 23,182,395,923
Total Revenue	IDR 26,236,713,500
Profit	IDR 3,054,317,573
Cost to Income Ratio (CIR)	88.36%
Return on Investment (ROI)	13.18%

The CIR value of 88.36% also indicates that a large proportion of revenue is allocated to covering operational costs. This suggests that although the business is profitable, it operates under relatively tight cost-efficiency constraints. Kartikawati et al. (2021)

found that cajuput oil yield is jointly determined by oil concentration and leaf biomass. Focusing solely on increasing oil concentration may adversely affect leaf biomass and ultimately reduce total oil yield. This finding indicates that business performance depends not only on controlling operational costs but also on maintaining balanced and sustainable oil yield productivity. Mahmudah et al. (2024) further emphasize that profitability in Cajuput oil businesses is highly sensitive to variations in yield, input costs, and selling prices. Therefore, although the business is feasible, the profitability remains vulnerable to fluctuations in key production and market variables.

Additionally, the ROI value of 13.18% shows that this business is profitable, as each unit of capital invested generates a return of 13.18%. According to Almestarihi et al. (2024), ROI is a key indicator in evaluating the effectiveness of investment decisions and financial performance across industries. Tantra et al. (2021) also suggested that an ROI exceeding prevailing interest rates reflects an attractive investment. However, this level of return should be interpreted with caution, as it depends on the stability of revenue and cost structures reflected in the CIR. In the Cajuput oil business, long-term sustainability is shaped not only by profitability but also by operational efficiency, resource management, and market conditions (Ermawati et al. 2021). This suggests that maintaining profitability at PMKP Sendang Mole requires continuous improvements in cost efficiency, production performance, and pricing strategies to sustain stable financial outcomes under changing economic conditions.

Sensitivity Analysis

In this research, sensitivity analysis was conducted to evaluate the extent to which adverse changes in production-related variables could be absorbed while maintaining the viability of Cajuput oil production at PMKP Sendang Mole. The analysis was based on observed fluctuations in production performance during 2018–2022, and a set of simulations was developed to examine the effects of these changes, as presented in Table 12.

From Table 12, Scenario I represents a reduction in the selling price to IDR 190,100, which was the lowest observed in 2018. This scenario was selected to capture

Table 12. Sensitivity analysis under simulated scenarios

Scenario	Variable Changed	Revenue (IDR)	Cost (IDR)	Profit (IDR)
Baseline	No change	26,236,713,500	23,182,395,927	3,054,317,573
Scenario I	Selling price decreased to IDR 190,100	20,747,704,100	23,182,395,927	-2,434,691,827
Scenario II	Selling price decreased to IDR 212,408	23,182,395,927	23,182,395,927	0
Scenario III	Yield decreased by 10%	23,613,042,150	23,182,395,927	430,646,223
Scenario IV	Raw material cost increased by 20%	26,236,713,500	26,151,912,801	84,800,699

the most adverse market condition historically experienced by the company and to assess the sensitivity of the cajuput oil business to a severe price decline. Under this condition, revenue decreased from IDR 26,236,713,500 under baseline conditions to IDR 20,747,704,100, while profit declined from IDR 3,054,317,573 to -IDR 2,434,691,827, indicating that the company would operate at a loss. Since revenue is determined by both the selling price/unit and the volume of output sold, a reduction in market price immediately weakens income generation. In agribusiness systems, output expansion remains closely associated with increased income generation (Ayompe et al. 2021). Moreover, pricing is widely recognized as a critical factor in maintaining business sustainability under fluctuating market conditions (Pattiruhu & Paais 2020).

In Scenario II, the selling price was reduced to IDR 212,408, corresponding to the BEP, where total revenue exactly equals total cost. This scenario was included to determine the minimum price threshold required for business continuity without incurring a profit or loss. As shown in Table 12, revenue under this condition was IDR 23,182,395,927, which was equal to the total production cost of IDR 23,182,395,927, resulting in zero profit. Therefore, this value defines the lower boundary of financial feasibility for the cajuput oil refining business. A selling price below this threshold would place the business in a financially unviable position. This interpretation is consistent with the view that a business becomes financially vulnerable when market prices can no longer cover production costs, even when businesses attempt to manage such fluctuations through internal financial strategies (Pattiruhu & Paais 2020). It is also consistent with Tilaye and Bukero (2024), who emphasized that companies unable to respond to declining market prices through cost adjustment tend to face weakened financial feasibility.

Table 12 further shows that Scenario III assumes a

10% reduction in yield. This scenario was developed from the largest historical decline observed in 2018, when yield decreased from 0.98% to 0.91%, a decline of approximately 8%. To more clearly capture the business sensitivity to production risk, the decline was simulated at 10%. Under this condition, revenue fell to IDR 23,613,042,150, while profit declined sharply to IDR 430,646,223. Yield represents the proportion of oil extracted relative to the dry weight of Cajuput leaves, and the level is influenced by extraction duration, solvent characteristics, and temperature control during distillation (Rachel et al. 2024). At the same time, upstream production conditions also matter, as land suitability and silvicultural management influence plant growth, biomass quality, and the availability of raw material for processing (Sadono et al. 2019). Therefore, a decline in yield reflects not only lower extraction efficiency but also a broader weakening of production performance, reducing output from the same quantity of raw material and ultimately constraining sales volume and profitability.

Scenario IV simulates a 20% increase in raw material costs to evaluate the business exposure to input price escalation. This scenario was considered relevant because raw material price volatility constitutes one of the principal external risks affecting production-based companies. The results indicate that revenue remained unchanged at IDR 26,236,713,500, as the selling price and sales volume were assumed to remain constant. However, total cost increased to IDR 26,151,912,801, causing profit to decline sharply to only IDR 84,800,699. This pattern indicates that rising raw material costs do not directly affect revenue but substantially erode profit margins. From a managerial perspective, businesses need to balance internal cost structures with external market conditions when determining selling prices, because pricing decisions remain central to business performance and long-term sustainability (Ibrahim & Harrison 2020).

Conclusion

This research demonstrates that Cajuput cultivation in the Yogyakarta Forest Management Unit is financially feasible, with a total investment cost of IDR 119,064,188,870, a production capacity of 93,647,000 kg/cycle, and an average annual profit of IDR 610,863,515, yielding an Income Ratio of 88.36% and an ROI of 13.18%. However, these results also indicate a structural vulnerability in the business model. The relatively moderate profit level compared to the large investment value indicates that profitability is highly sensitive to operational and market fluctuations. This is confirmed by the sensitivity analysis, which shows that reductions in selling price and yield can significantly reduce revenue and lead to financial losses. The requirement to maintain a minimum selling price above IDR 212,408/L further suggests that the business operates on tight margin and is exposed to external pressures, such as price competition and cost increases.

These results imply that financial feasibility alone is insufficient to ensure long-term sustainability without strong operational and strategic management. Practically, companies must prioritize cost efficiency, stabilize raw material supply, and improve yield through technological and process optimization. In addition, pricing strategies should be adaptive, taking into account market competition, consumer purchasing power, and input cost dynamics. The integration of profitability indicators such as ROI and CIR with sensitivity analysis is critical for supporting risk-based decision-making. Future research should incorporate market volatility, policy factors, and comparative analysis across production systems to better capture industry competitiveness. Integrated sustainability frameworks that combine financial, environmental, and social dimensions are also needed to provide a more comprehensive evaluation of the cajuput oil industry.

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