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Feasibility Analysis of PT X's Oil Palm Plantation Investment Using Capital Budgeting and Scenario Analysis

Chintya Christiana*, Indah Melati
Universitas Indonesia, Indonesia
Email: chintyachristiana@gmail.com*

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Abstract

Indonesia is the world's largest producer of crude palm oil (CPO). By 2024, national CPO production and stocks were projected to exceed 57 million tonnes, with allocations for exports of 29.5 million tonnes, biodiesel production of 12 million tonnes, and domestic food consumption of 11.1 million tonnes. This study aimed to analyze the investment feasibility of PT X's 300-hectare oil palm plantation expansion in West Kalimantan using capital budgeting and scenario analysis. A qualitative descriptive single-case study design was employed using primary data obtained from management interviews and field observations, as well as secondary data from PT X's internal financial model, Bappebti CPO data, Bank Indonesia government securities (Surat Berharga Negara/SBN) yield data, and Damodaran financial data. Eight financial evaluation methods were applied: Net Present Value (NPV), Internal Rate of Return (IRR), Payback Period (PP), Discounted Payback Period (DPP), Profitability Index (PI), Cost of Debt, Capital Asset Pricing Model (CAPM), and Weighted Average Cost of Capital (WACC). All feasibility indicators demonstrated positive results, with an NPV of IDR 23.978 billion at a 12% discount rate and IDR 20.459 billion based on a WACC of 13.16%; an IRR of 26.78%; a PP of 6.95 years; a DPP of 8.46 years; and a PI of 3.33. Scenario analysis across six land-price variations (IDR 15–34 million/hectare) confirmed investment feasibility under all scenarios, with IRR values ranging from 26.78% to 39.56%. The IRR–WACC spread of 13.62 percentage points indicated significant economic value creation, with an estimated Economic Value Added (EVA) of IDR 4.68 billion per year.

INTRODUCTION

Indonesia is the world's largest producer of crude palm oil (CPO). By 2024, national CPO production and stocks were projected to exceed 57 million tonnes, with allocations for exports of 29.5 million tonnes, biodiesel production of 12 million tonnes, and domestic food consumption of 11.1 million tonnes (BPDPKS, 2024). This commodity plays a strategic dual role as the largest contributor to foreign exchange earnings in the agricultural sector and as the primary raw material supporting the B35 biodiesel program, which is currently operational and absorbs approximately 13.2 million kiloliters annually. The post-pandemic recovery in CPO prices, which increased from the lowest level of Rp5,851.60/ton in November 2018 to a peak of Rp27,650.50/ton in March 2022 (Bappebti, 2022), encouraged plantation companies to expand production capacity to capitalize on favorable market conditions.

PT X is a foreign investment (Penanaman Modal Asing/PMA) palm oil plantation company established in the 1980s in West Kalimantan. With more than 40 years of operational

experience and a total managed area exceeding 20,000 hectares across several provinces in Indonesia, PT X has demonstrated strong technical capabilities. All plantations have updated Environmental Impact Assessments (Analisis Mengenai Dampak Lingkungan/AMDAL) and receive annual Indonesian Sustainable Palm Oil (ISPO) certification. After experiencing financial losses during 2018–2020, the company achieved significant financial recovery, recording profits of Rp99.683 billion in 2021 and Rp108.627 billion in 2022. This positive performance encouraged management to plan an expansion through the development of a new 300-hectare plantation area located separately from existing plantation sites (Faysse & Thomas, 2016; Safitri & Gandakusuma, 2019).

Large-scale and long-term plantation investment decisions require comprehensive feasibility analysis (Phimmavong et al., 2019; Romero & Putz, 2017). According to Ross et al. (2013), the capital budgeting process consists of three main stages: cost of capital analysis, cash flow estimation, and investment evaluation using quantitative methods. Damodaran (2001) emphasized the importance of determining an appropriate required rate of return through cost of capital calculations, which reflect all funding sources. Syahputra (2023) described business feasibility studies as comprehensive evaluations that provide a foundation for strategic investment decision-making. Meanwhile, Gitman and Zutter (2015) stated that scenario analysis, which evaluates the impact of different combinations of assumptions on project outcomes, provides a more realistic assessment of investment resilience under uncertain future conditions.

Several previous studies have examined investment feasibility in the Indonesian palm oil sector. Irawan and Pamungkas (2020) demonstrated the feasibility of oil palm plantation investments in South Aceh Regency based on positive NPV values and IRR values exceeding the cost of capital. Ali and Darto (2022) confirmed the feasibility of establishing a palm cooking oil factory in Jambi Province using NPV, IRR, Payback Period (PP), and Profitability Index (PI) methods. Muzakar et al. (2020) also identified the feasibility of palm oil processing projects in Indragiri Hilir, Riau. However, these studies share several limitations: they have not incorporated CAPM- and WACC-based cost of capital analysis as more accurate hurdle rates compared with the use of bank interest rates alone, and they have not applied systematic scenario analysis involving variations in land acquisition prices as one of the most critical risk variables in plantation investment. This research gap provides the primary motivation and contribution of the present study.

The novelty of this research lies in several key aspects. First, the integration of the Capital Asset Pricing Model (CAPM) with the Hamada equation (1972) to estimate levered beta for an unlisted company, combined with the Weighted Average Cost of Capital (WACC) calculation, provides a more accurate hurdle rate reflecting PT X's capital structure and risk exposure. The WACC value of 13.16% is higher than the 12% bank interest rate currently applied in PT X's financial model, providing a more conservative and realistic benchmark for investment evaluation. Second, the application of systematic scenario analysis across six land-price variations (Rp15–34 million/hectare) under ceteris paribus assumptions reveals the asymmetric impact of land acquisition costs on different feasibility indicators. This approach, based on Gitman and Zutter's (2015) scenario analysis framework, provides a more comprehensive understanding of investment resilience under land-price uncertainty, which represents one of the most critical and variable cost components in plantation investments. Third, the calculation of Economic Value Added (EVA) based on the IRR–WACC spread provides a clearer

measurement of economic surplus generated by the investment, enabling more informed comparisons with alternative investment opportunities (Wartono et al., 2024).

This research aimed to analyze the investment feasibility of PT X's 300-hectare oil palm plantation expansion using eight comprehensive evaluation methods: Net Present Value (NPV), Internal Rate of Return (IRR), Payback Period (PP), Discounted Payback Period (DPP), Profitability Index (PI), Cost of Debt, Capital Asset Pricing Model (CAPM), and Weighted Average Cost of Capital (WACC). In addition, scenario analysis involving six land acquisition price variations (Rp15–34 million/hectare) was conducted to evaluate the sensitivity and resilience of investment feasibility under land-price uncertainty, which represents one of the most critical factors in plantation investment decision-making.

METHOD

This study employed a qualitative descriptive approach using a single-case study method based on Yin (2018). The method was selected to obtain an in-depth understanding of investment feasibility by considering the specific characteristics of the study location (West Kalimantan), land classification (S3 mineral soil/PMK), and PT X's actual capital structure, which could not be fully captured through conventional quantitative approaches.

The research data consisted of primary and secondary sources (Prada-Ramallal et al., 2017). Primary data were obtained through in-depth interviews with PT X's management regarding construction cost assumptions, fresh fruit bunch (FFB) production projections during the mature plant (Tanaman Menghasilkan/TM) phase, financing plans, and risk considerations. Field observations were also conducted to verify land accessibility, supporting infrastructure conditions, and land suitability classification. Secondary data included PT X's internal financial model, financial reports for the 2018–2022 period, historical CPO price data from Bappebti (2022), productivity data for S3 land classification, 10-year Indonesian Government Securities (Surat Berharga Negara/SBN) yield data from Bank Indonesia (2024), Indonesia's equity risk premium data from Damodaran (2024), and unlevered beta data for the agribusiness sector from Damodaran (2024).

Data analysis was conducted through four sequential stages. The first stage involved descriptive financial analysis to prepare a 19-year financial projection (2024–2042) based on the collected assumptions. The projection included a four-year immature plant (Tanaman Belum Menghasilkan/TBM) phase (2024–2027) and a 15-year mature plant (TM) phase (2028–2042). The second stage involved calculating cost of capital components, including after-tax Cost of Debt using the formula $Kd(at) = Kd \times (1-t)$, cost of equity using the Capital Asset Pricing Model (CAPM) with the Hamada equation (1972) to estimate levered beta, and Weighted Average Cost of Capital (WACC) based on the Modigliani–Miller framework (1963). The third stage involved capital budgeting evaluation using five methods: Payback Period (PP), Discounted Payback Period (DPP), Net Present Value (NPV), Internal Rate of Return (IRR), and Profitability Index (PI). The fourth stage involved scenario analysis using six land acquisition price variations (Rp15, Rp18, Rp20, Rp25, Rp30, and Rp34 million/hectare) under fixed operational assumptions (ceteris paribus) to evaluate investment sensitivity and resilience toward changes in key risk variables.

The main assumptions established with PT X's management included a 300-hectare plantation area with S3 land classification, a planting density of 136 trees/hectare, expected FFB production at 80% of the Socfin standard, a bank interest rate of 12% per year, operational cost inflation of 5% per year, annual FFB price growth of 2%, a corporate income tax rate of

22% (HPP Law No. 7/2021), an initial FFB price of IDR 1,903,848/ton (TM-1 projection), and a base-case land acquisition price of Rp34 million/hectare. The CAPM parameters included a risk-free rate of 6.80% (average 10-year SBN yield in 2024 from Bank Indonesia), an Indonesia equity risk premium of 7.50% (mature ERP of 4.60% plus a country risk premium of 2.90%; Damodaran, 2024), and an unlevered beta of 0.72 for the agribusiness sector (Farming/Agriculture, emerging markets; Damodaran, 2024).

RESULTS AND DISCUSSION

Research Object Profile

PT X is a foreign investment (PMA) company operating in the oil palm plantation sector, established in the 1980s in West Kalimantan. The company group manages more than 20,000 hectares of land under Hak Guna Usaha (HGU) status, owns a CPO processing mill, and manages plantations with diverse plant age distributions (3–25 years) through routine monitoring using the Black Bunch Count method. The company's financial performance improved significantly after the pandemic period. PT X recorded losses of Rp9.654 billion in 2018, Rp42.258 billion in 2019, and Rp4.593 billion in 2020, before achieving a financial turnaround with profits of Rp99.683 billion in 2021 and Rp108.627 billion in 2022. Sales increased from IDR262.153 billion in 2019 to IDR510.923 billion in 2022, strengthening management confidence to undertake plantation expansion.

Capital Structure and Cost of Capital

PT X's investment is financed through two different sources: bank loans for physical plantation development costs amounting to Rp24.18 billion (D/V = 70.3%) and equity financing for land acquisition amounting to Rp10.20 billion (E/V = 29.7%). This financing structure results in a Debt-to-Equity (D/E) ratio of 2.37 and total investment capital of Rp34.38 billion. The use of equity financing for land acquisition represents a common practice in Indonesian agribusiness because banking institutions generally do not provide credit facilities for raw land acquisition without verified collateral.

The Cost of Debt was calculated using the Brigham and Houston (2019) formula:

$$\mathbf{Kd\ (after\ tax) = 12\% \times (1 - 0.22) = 9.36\%}$$

The total interest expense during the immature plant (TBM) period (2024–2027) reached IDR9.813 billion for the 300-hectare plantation area. This financial burden must be fully absorbed before the plantation generates revenue and therefore represents an important consideration in liquidity reserve planning.

The cost of equity was calculated using the Capital Asset Pricing Model (CAPM) proposed by Sharpe (1964) and Lintner (1965). Since PT X is not publicly listed, its beta cannot be directly estimated from market data. Therefore, the Hamada equation (1972) was applied to re-lever the unlevered beta of the agribusiness sector:

$$\mathbf{\beta_{levered} = 0.72 \times [1 + (1 - 0.22) \times 2.37] = 2.0515}$$

The resulting levered beta of 2.05 reflects the amplification of business risk caused by the company's high financial leverage. The cost of equity was subsequently calculated as:

$$\mathbf{Ke = 6.80\% + (2.0515 \times 7.50\%) = 22.17\%}$$

The cost of equity (Ke) of 22.17% is higher than the after-tax cost of debt (Kd) of 9.36%, which is consistent with the financial principle that equity holders, as residual claimants, require a higher expected return than debt holders due to greater risk exposure (Ross et al., 2022).

The Weighted Average Cost of Capital (WACC) was calculated using the Modigliani and Miller (1963) framework with tax adjustment, following Brealey et al. (2023):

WACC = (29.7% × 22.17%) + (70.3% × 9.36%)
WACC = 6.58% + 6.57% = 13.16% per year

The calculated WACC of 13.16% is slightly higher than the 12% discount rate applied in PT X's financial model. This indicates that the company's model used a hurdle rate below the actual cost of capital, resulting in a relatively optimistic NPV estimation of Rp3.52 billion. Nevertheless, the investment remains financially feasible, as the NPV recalculated using the WACC remains positive and substantial at Rp20.459 billion.

Table 1. Capital Structure and Components Capital Cost of PT X

Component	Value / Result	Formula / Source	Information
Bank Debt (D)	**Rp. 24.18 M = 70.3%**	Financial model of PT X	Cost development 300 Ha garden
Own Capital (E)	**Rp. 10.20 M = 29.7%**	Financial model of PT X	Liberation land @ Rp. 34 million / Ha
Kd After-Tax	**9.36%/ year**	12% × (1 − 0.22)	Relevant cost of debt for WACC
To – CAPM	**22.17%/ year**	6.80% + 2.0515 × 7.50%	β levered 2.05 via Hamada Eq.
WACC	**13.16%/ year**	(29.7%×22.17 %)+(70.3%×9.36%)	Real hurdle rate of PT X

Source : Financial model of PT X, Damodaran (2026), Bank Indonesia (2024), processed 2024.

Projection Cash Flow

Total investment the beginning of PT X (including land) reaches **Rp. 10,281 billion** during TBM phase 2026–2029. In 2024, the current go out the biggest occurred (Rp. 10,257.8 M) because covers liberation 300 Ha of land at once TBM-0 costs. In 2027–2029, the current go out Far more small (total Rp. 22.8 M) because only covers cost maintenance plants and loan interest. Entering TM phase starting 2030, plantation produce Fresh Fruit Bunches that produce current enter in the form of net income after tax . Fresh fruit bunch production grows from 8.8 tons/Ha (TM-1) to 21.6 tons/Ha (TM-8+), resulting in current increasingly incoming big every year. Table 2 shows projection 19 years complete cash flow.

Table 2. Projections PT X Investment Cash Flow — 300 Ha, Base Case, Discount Rate 12%

Year	Phase	NCF (Rp M)	DF (12%)	PV NCF (Rp M)	Kum CF (Rp M)	Kum PV (Rp M)	Information
2026	TBM-0	(10,257.8)	1,0000	(10,257.8)	(10,257.8)	(10,257.8)	—
2027	TBM-1	(5.6)	0.8929	(5.0)	(10,263.4)	(10,262.8)	—
2028	TBM-2	(7.4)	0.7972	(5.9)	(10,270.8)	(10,268.7)	—
2029	TBM-3	(9.8)	0.7118	(7.0)	(10,280.6)	(10,275.7)	—
2030	TM-1	961.9	0.6355	611.3	(9,318.8)	(9,664.4)	—
2031	TM-2	3,754.7	0.5674	2,130.5	(5,564.1)	(7,533.9)	—
2032	TM-3	5,836.0	0.5066	2,956.7	272.0	(4,577.2)	← PP
2033	TM-4	6,944.3	0.4523	3,141.2	7,216.3	(1,435.9)	—
2034	TM-5	7,806.6	0.4039	3,153.0	15,022.9	1,717.0	← DPP
2035	TM-6	8,704.0	0.3606	3,138.7	23,726.9	4,855.8	—
2036	TM-7	8,985.2	0.3220	2,893.0	32,712.0	7,748.8	—
2037	TM-8	10,104.7	0.2875	2,904.9	42,816.7	10,653.6	—
2038	TM-9	9,877.2	0.2567	2,535.2	52,694.0	13,188.9	—
2039	TM-10	9,850.9	0.2292	2,257.6	62,544.8	15,446.4	—
2040	TM-11	10,267.2	0.2046	2,100.9	72,812.0	17,547.3	—

Year	Phase	NCF (Rp M)	DF (12%)	PV NCF (Rp M)	Kum CF (Rp M)	Kum PV (Rp M)	Information
2041	TM-12	10,308.4	0.1827	1,883.3	83,120.4	19,430.6	—
2042	TM-13	10,342.1	0.1631	1,687.0	93,462.5	21,117.6	—
2043	TM-14	10,367.9	0.1456	1,510.0	103,830.4	22,627.6	—
2044	TM-15	10,385.1	0.1300	1,350.5	114,215.5	23,978.1	—
Total	**—**	**114,215.5**	**—**	**23,978.1**	**—**	**—**	**NPV = Rp 23,978 M**

NCF = Net Cash Flow; DF = Discount Factor; PV = Present Value. Brackets = negative . PP is achieved in TM-3 (2032) when the Cumulative CF is first positive. DPP is achieved in TM-5 (2034) when the Cumulative PV is first positive. Source : Financial model of PT X, processed in 2024.

Net Present Value (NPV). The formula NPV = Σ[CFt /(1+ r)^{t}] with t = 0 to 19. NPV measures mark now the surplus created investment above cost of capital — the most consistent method with objective maximize mark holder share Because take into account all cash flow and value time money (Brealey et al., 2023). Investment worthy if NPV ≥ 0.

NPV (@ 12 %) = Rp. 23.978 billion
NPV (@ WACC 13.16 %) = IDR 20.459 billion

Positive NPV at both discount rates confirms that investment create mark substantial clean after All capital is returned and capital costs are paid . The difference is Rp 3.52 billion. between both of them is consequence direct from use of more hurdle rates accurate (WACC). Analysis sensitivity shows a fixed NPV positive up to a discount rate approaching 26.78% (IRR), providing a very wide margin of safety to possibility increase future capital costs .

Internal Rate of Return (IRR). IRR is the discount rate that makes NPV = 0, calculated iterative through Newton-Raphson method . Investment worthy if IRR > hurdle rate (Ross et al., 2022).

IRR = 26.78% per year → margin 14.78 pp above hurdle rate 12 % and 13.62 pp above WACC 13.16%

IRR 26.78% represents the effective return generated every rupiah invested for 19 years. This figure competitive compared to the average return of the IHSG over the long term long (10–12% per year) and far beyond instrument conservative like bond or deposits . The IRR margin against WACC (13.62 pp) is very wide — almost The same big with that WACC alone — indicates that project Still profitable even If condition operational worsening in a way significant.

Payback Period (PP)

PP measures time nominal capital recovery without take into account mark time money. Formula linear interpolation (Gitman & Zutter, 2015): PP = n + |Kum CF negative last | / |NCF year positive first |. From Table 2, Kum CF changes from -Rp 5,564.1 M (2031) to +Rp 272.0 M (2032):

PP = 6 + 5,564.1 / (5,564.1 + 272.0) = 6.95 years ≈ mid- 2032

Discounted Payback Period (DPP)

DPP improves PP's weakness with accumulate the present value of cash flows , not the nominal value. More conservative and realistic Because take into account mark time money (Brigham & Houston, 2019). From Table 2, Kum PV changes from -Rp 1,435.9 M (2033) to +Rp 1,717.0 M (2034):

DPP = 8 + 1,435.9 / (1,435.9 + 1,717.0) = 8.46 years ≈ mid- 2034

Difference between DPP − PP = 1.51 years show moderate impact of time value of money. For institutional investors with a horizon of ≥ 10 years, DPP 8.46 years Still within the limits that can be accepted. The DPP should used as reference main — not PP — because give

a clearer picture realistic about when the capital is really return in equivalent value with moment invested.

Profitability Index (PI)

PI (or Benefit-Cost Ratio) measures capital efficiency : the present value generated per rupiah of investment Initial (Damodaran, 2012). Formula: PI = PV of Inflow / |Total Initial Investment |. Total investment initial Rp 10,281 M; PV current entered at 12% amounting to Rp. 34,254 M:

PI (12 %) = 3.33 | PI (WACC 13.16 %) = 2.99

PI 3.33 means every Rp. 1 investment generates Rp 3.33 in present value of cash flow in — a net surplus of Rp 2.33 per rupiah. Even at a WACC of 13.16%, the PI is still 2.99. This value become very relevant if PT X plans compare a number of project expansion in a way simultaneously in condition capital constraints: projects with more PI tall should prioritized.

Table 3. Summary All over Indicator Eligibility Investment of PT X

Indicator	Mark	Threshold	Decision
NPV (@ 12%)	**Rp. 23,978 billion**	≥ Rp 0	**✓ WORTHY — surplus value of Rp. 23,978 M**
NPV (@ WACC 13.16%)	**Rp. 20,459 billion**	≥ Rp 0	**✓ WORTHY — still positive on the real cost of capital**
IRR	**26.78%/ year**	> 12%; > WACC	**✓ WORTH — 2.23× hurdle rate**
Payback Period	**6.95 years (~2030)**	< 19 years	**✓ WORTHY — nominal capital return < 7 years**
Discounted PP	**8.46 years (~2032)**	< 19 years	**✓ WORTH — including time value of money**
Profitability Index (12%)	**3.33**	≥ 1.0	**✓ WORTHY — Rp 3.33 PV per Rp 1 investment**
PI (@ WACC 13.16%)	**2.99**	≥ 1.0	**✓ VALUABLE — efficient at real cost of capital**
Cost of Debt After Tax	**9.36%/ year**	< IRR	**✓ The cost of debt is far below the project's return**
To — CAPM	**22.17%/ year**	< IRR	**✓ Cost equity still below IRR**
WACC	**13.16%/ year**	< IRR	**✓ Real cost of capital < project return**
Spread IRR − WACC	**13.62 pp**	Positive	**✓ EVA > 0 (~Rp 4.68 M/ year)**

Source : Calculation based on the financial model of PT X, Damodaran (2026), processed 2024.

Economic Value Added

Spread IRR−WACC = 26.78% − 13.16% = 13.62 pp proves that project No just worthy in a way technical , but rather create mark economy real for all over funders . Referring to the EVA concept: EVA = Spread × Total Capital = 13.62% × Rp 34.38 M ≈ **Rp 4.68 billion per year** . This is the economic surplus the remaining real after bank creditors earn interest and equity investors get the appropriate return the risks they take responsibility . With an IRR almost twice the WACC, the project create very competitive value in context investment term long in Indonesia.

Scenario Analysis of Land Prices Land

Acquisition Prices land chosen as variables scenario Because three reason strategic: completely determined before construction started so that No can revised after transactions, the most varied in the field (Rp. 10–60 million /Ha depending on location and accessibility), and not depending on the conditions operational that can controlled management. Six scenarios

tested with assumptions operational fixed (ceteris paribus) according Gitman and Zutter's (2015) scenario analysis approach.

Table 4. Scenario Analysis Results — Land Price Variations , 300 Ha

Scenario	Land Price	NPV (Rp M)	IRR (%/ yr)	PP (Year)	DPP (Year)	Status
A – Very Optimistic	Rp. 15 million / Ha	**29,678**	**39.56%**	5.96	6.62	✓ **Worthy**
B – Optimistic	Rp. 18 million / Ha	**28,778**	**36.48%**	6.13	6.92	✓ **Worthy**
C – Good Enough	Rp. 20 million / Ha	**28,178**	**34.77%**	6.23	7.12	✓ **Worthy**
D – Moderate	Rp. 25 million / Ha	**26,678**	**31.28%**	6.49	7.60	✓ **Worthy**
E – Upper Limit	Rp. 30 million / Ha	**25,178**	**28.57%**	6.75	8.07	✓ **Worthy**
F – Base Case	Rp. 34 million / Ha	**23,978**	**26.78%**	6.95	8.46	✓ **Worthy**

Source : Calculation based on the financial model of PT X, processed in 2024.

All scenarios generated positive NPV values and IRRs above the hurdle rate, demonstrating that investment feasibility does not depend on a single land price assumption. However, the declining pattern observed across scenarios reveals an important finding regarding the asymmetric impact of land price changes. A land price difference of Rp19 million/hectare between Scenario A and Scenario F shifted the IRR by nearly 13 percentage points (39.56% to 26.78%), representing a substantially larger proportional impact compared with the effect on absolute NPV (which decreased by only 19%) and on PP/DPP (which changed by 1 and 1.84 years, respectively). This asymmetry occurs because IRR is highly sensitive to the relationship between initial investment and future cash inflows: the higher the land acquisition price, the larger the initial capital requirement and the lower the return ratio generated per rupiah invested.

The practical implications of this finding are significant. Every Rp1 million/hectare reduction in land price for a 300-hectare area reduces the initial investment requirement by Rp300 million and increases the IRR by approximately 0.7 percentage points. The ideal target is therefore to acquire land at a price below Rp25 million/hectare (Scenario D), allowing the IRR to remain above 31% with a DPP of less than 7.6 years. This condition provides stronger resilience against various operational disruptions. These findings confirm that land price negotiation capability represents a strategic competency for PT X, with a value equal to, or even exceeding, agronomic advantages in determining the final investment return.

Beta Sensitivity Analysis and Principal Risks

Since beta represents the most uncertain parameter for an unlisted company, sensitivity analysis was conducted using an unlevered beta range of 0.60–0.85. The results showed that the WACC ranged from 12.40% to 13.99%, with NPV values varying between Rp17.26 billion and Rp23.08 billion. All scenarios remained positive, confirming that the investment feasibility conclusion does not depend on a single beta assumption.

Three main structural risks require proactive mitigation strategies:

First, inflation asymmetry risk. Operational costs are projected to increase by 5% per year, while FFB prices are expected to increase by only 2% per year. This 3-percentage-point gap gradually reduces operating margins from 68.1% in TM-8 (2037) to 60.9% in TM-15

(2044). Without planned efficiency interventions, this pressure may continue beyond 2042 and eventually threaten the long-term viability of plantation operations. Therefore, PT X is recommended to initiate harvesting and transportation cost-efficiency programs starting from TM-5 (2032), when cash flow conditions become stronger.

Second, initial mature plant (TM) liquidity risk. The TM-1 to TM-3 period (2030–2032) represents the most vulnerable stage, as cumulative cash flow remains negative throughout this period. Production disruptions, such as El Niño events, large-scale pest attacks, or unexpected cost increases, could directly extend the PP and DPP periods and potentially affect the company's ability to meet bank loan obligations. Maintaining an operating fund reserve of 15–20% of projected costs is therefore recommended.

Third, fresh fruit bunch (FFB) price risk. A 15% decline in FFB prices from the projected level (comparable to the CPO price decline cycle during 2015–2016) would reduce the IRR to approximately 18–20%. Although the investment would remain above the hurdle rate, the safety margin would narrow considerably. With an IRR–WACC buffer of 13.62 percentage points under the base-case scenario, the project is still capable of absorbing a reasonable level of price decline before reaching the point of infeasibility.

Comparatively, the findings of this study are consistent with previous research by Irawan and Pamungkas (2020), Ali and Darto (2022), and Muzakar et al. (2020), which confirmed the investment feasibility of palm oil plantation and processing projects in South Aceh, Jambi, and Riau. These studies reported positive NPV values and IRRs exceeding capital costs for Indonesian palm oil projects. However, this study provides two additional contributions that have not been explicitly addressed in previous studies.

The first contribution is the integration of CAPM and WACC as a more accurate hurdle rate determination approach. The WACC-based calculation of 13.16% produces an NPV that is Rp3.52 billion lower than the valuation using the company's 12% bank-based discount rate, indicating that the direct use of bank interest rates tends to overestimate investment value. This finding is important for plantation finance practitioners in establishing more realistic investment benchmarks.

The second contribution is the identification of the asymmetric impact of land prices through scenario analysis. Land price variations have highly different effects across feasibility indicators: a dominant impact on IRR (13 percentage points for a Rp19 million/hectare difference), a moderate impact on NPV (19% reduction), and minimal effects on PP/DPP (approximately 1–2 years). This asymmetric sensitivity pattern has not been explicitly identified in previous Indonesian palm oil plantation investment feasibility literature.

CONCLUSION

The 300-hectare oil palm plantation expansion investment by PT X in West Kalimantan was determined to be financially feasible based on eight integrated capital budgeting indicators. The project generated an NPV of Rp23.978 billion at a discount rate of 12% and Rp20.459 billion at a WACC of 13.16%, with an IRR of 26.78%, a Payback Period (PP) of 6.95 years, a Discounted Payback Period (DPP) of 8.46 years, and a Profitability Index (PI) of 3.33. These results consistently confirmed investment feasibility under both discount rate scenarios. The IRR–WACC spread of 13.62 percentage points indicated that the project was not only financially feasible but also capable of creating significant economic value, with an estimated Economic Value Added (EVA) of IDR 4.68 billion per year.

Scenario analysis involving six land-price variations (Rp15–34 million/hectare) confirmed investment feasibility across all scenarios. The main finding revealed an asymmetric impact of land prices on investment performance: a Rp19 million/hectare change in land price shifted the IRR by nearly 13 percentage points, while reducing NPV by only 19% and extending the PP/DPP by approximately 1–2 years. Land acquisition price was identified as the most dominant determinant of profitability, confirming that land negotiation capability represents a strategic factor influencing investment returns. The CAPM-based WACC of 13.16% is recommended as the appropriate hurdle rate to replace the 12% bank interest rate currently applied in PT X's investment model.

This study has several limitations. First, the analysis primarily focused on financial aspects and did not incorporate broader socio-environmental dimensions. Second, the scenario analysis considered only a single variable and did not evaluate multivariate risk interactions. Third, the projection horizon was limited to the TM-15 period and did not include the terminal value of plantation assets from TM-16 to TM-25. Fourth, the unlevered beta applied in the CAPM calculation was based on a general emerging-market agribusiness benchmark rather than issuer-specific beta estimates derived from listed Indonesian palm oil companies.

Future research is recommended to apply multivariate Monte Carlo simulation, extend financial projections through the TM-25 period, and develop sector-specific beta estimates using listed palm oil companies on the Indonesia Stock Exchange (IDX), such as AALI, LSIP, and SIMP.

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