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Strategy for Optimizing Oil Palm Plantation Productivity Through Barangan Banana Intercropping During Replanting Period (Case Study: PT Agricinal)

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ABSTRACT
The declining productivity of oil palm plantations exceeding the optimal productive age (>25 years) poses significant financial challenges for plantation companies. PT Agricinal experienced a drastic decrease in Fresh Fruit Bunch (FFB) productivity from 6.41 tons/ha/year in 2020 to 3.92 tons/ha/year in 2022—far below the ideal standard of 25–30 tons/ha/year. This condition triggered a replanting decision in 2022 but created a 3–4-year non-productive period (*Tanaman Belum Menghasilkan*/TBM) without operational revenue. This research aims to analyze the financial feasibility of Barangan banana intercropping on 1,000 ha of replanting land as a revenue optimization solution. The research methodology employs a mixed-methods approach that combines quantitative business feasibility analysis—using Net Present Value (NPV), Internal Rate of Return (IRR), Net Benefit-Cost Ratio (Net B/C), Payback Period (PP), sensitivity analysis, and SWOT analysis indicators—with qualitative insights. Research findings demonstrate that Barangan banana intercropping provides significant improvements in financial feasibility: NPV increased 66.8%, from IDR 58.63 billion to IDR 97.79 billion; IRR increased from 25% to 45%; Net B/C increased from 1.65 to 1.77; and Payback Period shortened from 6 years to 4 years. Sensitivity analysis proves the project's resilience to fluctuations in CPO prices, operational costs, and FFB productivity. The intercropping strategy effectively fills cash flow gaps during the TBM period, enhances land use efficiency, and strengthens plantation business competitiveness. This research concludes that implementing Barangan banana intercropping on oil palm replanting land is feasible and strategic for large-scale application as a sustainable agribusiness model.
Keywords: oil palm, replanting, intercropping, Barangan banana, financial feasibility

INTRODUCTION

Palm oil stands as the world's most consumed vegetable oil, accounting for 40% of global vegetable oil supply despite occupying only 10% of total oil crop land area (Agribusiness Strategy Management, 2023; Suci, 2015; Nur'azkiya et al., 2020). Global production reached 78.4 million metric tons in 2023, with Indonesia and Malaysia collectively contributing 85% of total output. However, this critical agricultural commodity faces an intensifying productivity crisis driven by plantation aging. Approximately 17.3 million hectares of global oil palm plantations have surpassed 20 years of age, with productivity declining 30–45% compared to peak productive years. This demographic shift in plantation age structure threatens long-term supply stability and creates urgent replanting imperatives across major producing nations (Asmarantaka et al., 2017; Nataliningsih et al., 2018).

Indonesia, as the world's largest palm oil producer with 16.7 million hectares under cultivation (Directorate General of Plantations, 2023), confronts particularly acute challenges. An estimated 3.2 million hectares—approximately 19% of total planted area—exceeded optimal productive age (*>25 years*) by 2023 and require systematic replanting within the next decade (Indonesian Palm Oil Association/GAPKI, 2023). The Indonesian government's national replanting program targets 185,000 hectares annually, yet actual achievement remains at 60–70% of targets due to financial constraints faced by both smallholders and plantation

companies. This replanting deficit accumulates annually, exacerbating the productivity crisis and threatening Indonesia's competitive position in global palm oil markets (Ammar, 2025; Winarti, 2016).

The replanting process imposes severe financial burdens through the mandatory 3–4-year immature period (*Tanaman Belum Menghasilkan*/TBM), during which zero revenue is generated while operational costs, land rental payments, labor expenses, and capital servicing obligations continue unabated. Financial modeling indicates that replanting one hectare requires capital investment of IDR 35–45 million (USD 2,300–3,000) for land clearing, seedling procurement, planting operations, and initial maintenance, while generating negative cash flows averaging IDR 15–20 million annually during the TBM period. For large-scale plantation companies operating on thin profit margins (8–12% EBITDA in typical market conditions), simultaneous replanting of extensive areas creates liquidity crises, debt covenant violations, and heightened bankruptcy risks (Asmarantaka et al., 2017; Nataliningsih et al., 2018).

Secondary data from the Indonesian Central Statistics Agency (*Badan Pusat Statistik*/BPS, 2023) reveals that 42% of plantation companies postponed scheduled replanting activities during 2020–2022 due to cash flow constraints, contributing to a national replanting backlog exceeding 580,000 hectares. This deferral strategy, while preserving short-term liquidity, accelerates long-term productivity decline: plantations aged 28–30 years produce only 8–12 tons FFB/ha/year compared to 25–30 tons/ha/year for prime-age plantations (ages 8–18 years), representing a 60% productivity loss and proportional revenue reduction (Indonesian Oil Palm Research Institute/IOPRI, 2023). The compounding effect of aging plantations and delayed replanting creates a negative spiral of declining revenues, constrained replanting capacity, and further productivity deterioration.

Palm oil is one of the strategic sectors in the Indonesian economy, contributing substantially to exports, labor absorption, and rural development (Agribusiness Strategy Management, 2023; Suci, 2015; Nur'azkiya et al., 2020). Indonesia is the world's largest producer of palm oil, with production reaching 50 million tons per year and controlling around 58% of the global market share. PT AGRICINAL, established in 1981, began business activities and has held *Hak Guna Usaha* (HGU) since 1985. The company built oil palm nurseries and plantations and currently manages an HGU area of 6,269 ha consisting of 12 *afdelings*. The company also operates a palm oil mill (POM) with a processing input capacity of 30 tons of FFB/hour; this plant produces CPO (*Crude Palm Oil*) and PK (*Palm Kernel*) as main products. The company has producing crop (*Tanaman Menghasilkan*/TM) areas, with the oldest planting year of 1986.

The productivity of oil palm plants is greatly influenced by plant age. Entering the age of over 25 years, oil palm trees experience physiological decline, which directly impacts fresh fruit bunch (FFB) production. This decline causes output to fall below ideal standards, significantly affecting company revenue. Ideal oil palm crops can produce 25–30 tons FFB/year. Data show that FFB productivity at PT AGRICINAL is very low: in 2020, the average was 6.41 tons FFB/ha/year, but in 2022, it decreased drastically to 3.92 tons/ha/year. Therefore, company management decided to initiate replanting in 2022.

To maintain productivity sustainability, plantation business actors must replant or rejuvenate plants (Abubakar et al., 2023; Silva et al., 2019; Suroso et al., 2020). Replanting involves replacing old plants with new, superior seedlings that are more productive; however, this process creates a TBM period of 3–4 years, during which there is no crop income while operational costs continue. This condition poses severe financial challenges, especially for companies dependent on cash flows from FFB sales.

To address these challenges, innovative strategies are needed to generate additional income during the TBM period. One promising approach is intercropping—planting other

commodities among young oil palm plants. The selected commodity must have a fast harvest cycle, stable market value, and agronomic compatibility with oil palm. In this context, bananas represent a viable alternative.

Bananas are adaptive to various soil types and tropical climates, capable of producing harvests three times in two years. They also have high commercial value in domestic and export markets, with relatively stable demand. These potential positions banana intercropping in oil palm replanting areas as a solution to bridge income gaps during the TBM period.

This study examines the financial and operational feasibility of the oil palm–banana intercropping model and provides strategic recommendations for plantation business actors to optimize income during replanting. It aims to contribute to sustainable agribusiness models adaptive to production cycle challenges (GEOFORUM, 2024; Purwanigrahayu, 2025).

This study identifies key problems, including: (1) decreased productivity in oil palm plantations due to plants exceeding the optimal productive period, prolonged dry seasons, and CPO price fluctuations in global markets; (2) cash flow pressure during replanting, with reduced crop revenue amid high financing needs for replanting and operations; and (3) lack of comprehensive business feasibility analysis for intercropping, particularly with bananas as a land optimization strategy during replanting.

Based on these problems, the study addresses the following research questions: (1) How can a business feasibility analysis model be simulated for the replanting period without intercropping? (2) How can a business feasibility analysis model be simulated for the replanting period with Barangan banana intercropping? (3) How can a strategy be formulated to optimize business outcomes through banana intercropping?

The objectives of this study align with these questions: (1) develop a simulation of a business feasibility analysis model for replanting without intercropping; (2) develop a simulation of a business feasibility analysis model for replanting with banana intercropping; and (3) formulate a strategy to optimize business outcomes through banana intercropping.

This study offers the following benefits: it contributes to agribusiness management science, particularly financial performance and feasibility analysis in plantations; provides a reference for future research on income optimization via intercropping in agriculture; aids decision-making for palm oil businesses on whether banana intercropping improves performance; supports PT AGRICINAL's strategic decisions on replanting and intercropping to manage cash flow and optimize revenue; and serves as a reference for academics, practitioners, and government policymakers formulating supportive intercropping policies. It also enhances understanding of oil palm business optimization through banana intercropping.

RESEARCH METHOD

This research was carried out on replanting land owned by PT AGRICINAL in Putri Hijau District, North Bengkulu Regency. The location was selected based on its representative characteristics as an oil palm replanting area with banana intercropping practices. The research period spanned from April 15, 2023, to April 15, 2025, enabling comprehensive observation of growth dynamics and income potential over one *Pisang Barangan* planting cycle during the oil palm replanting period. Researchers examined 1,000 hectares of land designated for replanting, with 10% of the area planted with intercropping *pisang Barangan*. (Ferdinand, 2014).

The data for this study were sourced from primary and secondary data. Primary data were obtained through interviews and questionnaires completed by respondents, while secondary data were collected from scientific journals, literature reviews, and valid, relevant websites. Further details on the types and sources of data used in this study are presented in the following table:

Table 1. Types and sources of research data

Data Type	Required Data	Data Analysis	Data Source
Data Primer	1. Results of observations and interviews	Financial Analysis (NPV, IRR, Net B/C, Payback Period) Sensitivity Analysis *SWOT*	Company
Data Seconds	1. Company report 2. Data statistics 3. Other supporting data sources		1. Plantation Service 2. Central Statistics Agency 3. Journal 4. Website 5. Scientific research (thesis & dissertation)

The data collection technique in this study used the survey method, a common approach in descriptive research. Researchers routinely observed the development and growth of young oil palm plants during the replanting period, as well as monitored the growth and development of bananas planted as intercrops. These observations covered a wide range of relevant agronomic parameters. In addition to observation, interviews served as a key instrument for obtaining in-depth information. Structured interviews used pre-prepared question guides to ensure consistency in data collection from each respondent, while semi-structured interviews allowed flexibility to explore emerging topics during conversations with PT AGRICINAL's management and staff.

In addition to primary data, this study relied on secondary data from various sources. The main method for secondary data collection was a literature study, which reviewed scientific publications, books, journals, theses, and previous research relevant to plantation income optimization, intercropping concepts, banana characteristics, oil palm replanting, official statistical data from government agencies, and agribusiness supply chain management.

Net Present Value (NPV) is the difference between total receipts and expenses that have been discounted at present value. A project is said to be feasible to run if the NPV value is greater than zero (NPV > 0). Conversely, if the NPV is less than or equal to zero (NPV ≤ 0), the project is considered unfeasible. This concept considers the benefits (Bt) and costs (Ct) in the tth year, the economic life of the project (n), and the prevailing interest rate (i) to determine the feasibility of the investment. The NPV formula in the project analysis is written as follows:

$$NPV = \sum_{t-1}^{t} \frac{C_t}{(1+r)^t} - C_0$$

Where:

Bt = Benefit (Business revenue in the tth year)
Ct = Cost (Business Expenses in the T Year)
n = Economic life of the project
i = Applicable interest rate

A project is said to be feasible when it produces an NPV of > 0. If the NPV is ≤ 0, then the project is not suitable for implementation.

The Internal Rate of Return (IRR) is the rate of profit on net investments equal to the interest rate earned during the remaining life of the business. Conceptually, IRR looks for a discount rate that makes the Net Present Value (NPV) of a project zero. A project or business is said to be feasible to run if the IRR value is greater than or equal to the applicable social

discount rate. Conversely, if the IRR is lower than the social discount rate, the project is considered unfeasible. The calculation of IRR involves a comparison between positive and negative NPVs at different interest rates.

$$IRR = i_1 + \frac{NPV_1}{(NPV_1 - NPV_2)}(i_2 - i_1)$$

Description:
NPV1 = NPV with a positive value
NPV2 = NPV with a negative value
I1 = The interest rate when generating an NPV Positive value
I2 = Interest rate when generating NPV with a negative value

The Net Benefit-Cost Ratio (Net B/C) is a comparison between the difference between positive benefits and negative benefit costs, with the main focus on the magnitude of the benefits obtained. This criterion indicates that a project is said to be feasible and profitable if the Net B/C value is greater than 1 (Net B/C > 1). If Net B/C is equal to 1, the business is not profitable and does not lose, while if Net B/C is less than 1 (Net B/C < 1), the business is considered detrimental and not accepted. This calculation takes into account the gross revenue (Bt) and gross cost (Ct) of the business in the t-year, the economic life of the project (n), and the applicable interest rate (i). The formulation used is:

$$\text{Net}\frac{B}{C} = \frac{\sum_{t=1}^{n}\frac{B_t - C_t}{(1+i)^t}}{\sum_{t=1}^{n}\frac{B_t - C_t}{(1+i)^t}}$$

Description:
Bt = Benefit (Gross revenue of the business in the tth year)
Ct = Cost (gross cost of business in the t-year)
n = Economic life of the project
i = Applicable interest rate

The criteria that can be obtained from the calculation of Net B/C include:
Net B/C > 1, then the business is profitable
Net B/C = 1, then the business is unprofitable and not detrimental
Net B/C < 1, then the business is detrimental

Payback Period (PP) is the period that manufacturers need to return all investment costs that have been incurred. This analysis is generally used to identify projects that can return the initial investment the fastest, making them the top choice to execute. Payback Period can be calculated with the following formula:

$$PBP = T_{p-1} + \frac{\sum_{i=1}^{n} I_i - \sum_{i=1}^{n} B_{icp-1}}{B_p}$$

Description:
Tp-1 = Year before payback period

Ii = The amount of investment that has been made discount
Bicp-1 = Total Benefit who have been in the discount Before payback period
Bp = Quantity Benefit on payback period

Sensitivity Analysis is a method used to evaluate the potential impact of errors or changes in basic assumptions in the calculation of costs and benefits on the results of business analysis. The goal is to identify crucial variables, reduce uncertainty, and highlight areas that require close monitoring to ensure economically profitable outcomes. This analysis is essential because future projections are fraught with uncertainty, so any possible changes must be tested and re-analyzed. Some of the key parameters that can cause changes and be analyzed in sensitivity include: Increase in Production Costs: Influenced by the price of means of production or labor. Product Price Decline: The maximum rate of price decline experienced by the manufacturer. Decrease in the Amount of Production: The maximum level of decline in production resulting from a decrease in labor productivity.

Analysis SWOT is a crucial strategic planning tool for identifying an organization's internal strengths and weaknesses, as well as external opportunities and threats. This analysis systematically evaluates the company's market position and becomes the basis for strategic decision-making. The main logic is to maximize strengths and opportunities, while minimizing weaknesses and threats. According to David (2010) the matrix SWOT help managers formulate four types of strategies: Strengths (Strengths), Internal company advantages. Disadvantages (Weaknesses), Internal limitations of the company. Opportunities (Opportunities), External factors that can be utilized. Threats (Threats), External factors that have the potential to negatively impact. From this matrix, a strategy was developed: SO Strategy: Harnessing power to seize opportunities. WO Strategy: Fixing weaknesses by taking advantage of opportunities. ST Strategy: Use force to avoid or mitigate threats. WT strategy: Defensive tactics to reduce weakness and avoid threats.

The purpose of the SWOT analysis is to help the company understand its current position, identify areas for improvement, and drive growth and expansion. This analysis is flexible, can be applied to products, organizations, and industries, and can be done through brainstorming, group discussions, or surveys.

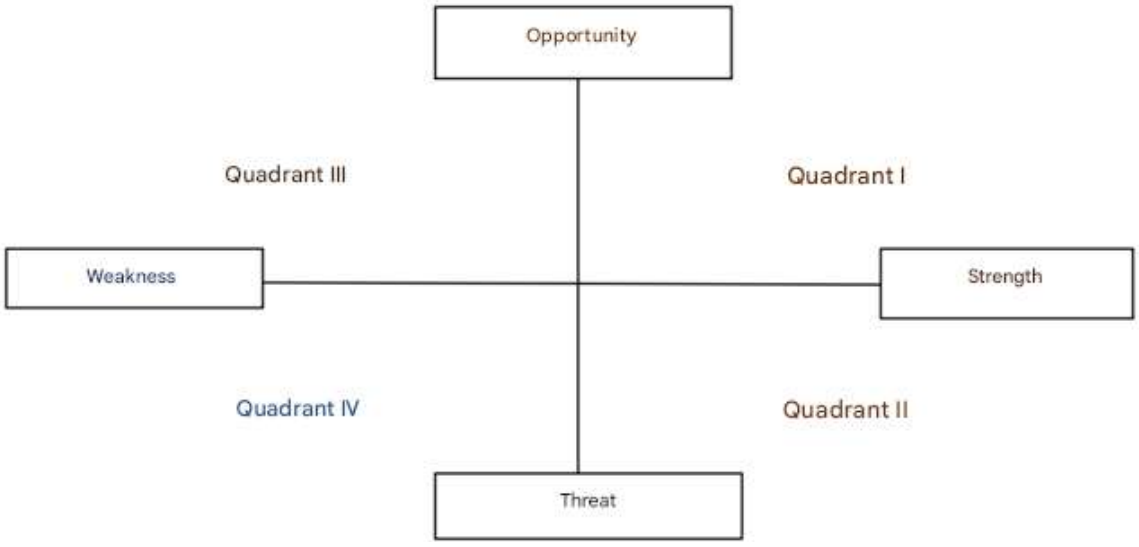

Figure 1. Analysis diagram *SWOT*

Quadrant I (Strength-Opportunity): A highly advantageous situation in which the company has internal power to take advantage of external opportunities. The right strategy is

an aggressive growth policy (Growth-oriented strategy). Quadrant II (Strengths-Threats): The company faces threats but is supported by internal forces. The recommended strategy is to use those strengths to capitalize on long-term opportunities, often through product/service diversification. Quadrant III (Weakness-Opportunity): The company is faced with a large market opportunity but is constrained by internal weakness, similar to the position of the Question Mark in the BCG matrix. The focus of the strategy is to minimize internal problems in order to seize market opportunities. Quadrant IV (Weakness-Threat): This is a very unfavorable situation, where the company faces various external threats and internal weaknesses.

Table 2. SWOT Matrix

Internal Factors / External Factors	Strengths	Weaknesses
Opportunities	**SO Strategy** Utilize strengths to capture and leverage opportunities as much as possible.	**WO Strategy** Strategy applied based on existing opportunities by minimizing existing weaknesses.
Threats	**ST Strategy** Strategy applied based on strengths possessed by the organization to overcome threats.	**WT Strategy** Strategy applied based on defensive activities and efforts to minimize existing weaknesses while avoiding threats.

RESULTS AND DISCUSSION

Corporate Financial Performance

An analysis of the company's financial performance is carried out to assess the extent to which the company can manage financial resources effectively and efficiently in supporting operations and achieving business goals. This assessment usually includes several key indicators such as revenue growth, net profit, profit margin, as well as financial ratios such as Return on Assets (ROA) and Return on Equity (ROE). During the analysis period, the company showed a steady revenue growth trend, despite facing external challenges such as market fluctuations. The company's net profit also increased in line with the efficiency of operating costs that were applied consistently. In addition, the liquidity and solvency ratios are at healthy levels, indicating the company's ability to meet its short-term and long-term obligations. This positive financial performance is an important capital for companies to replant.

The author made a feasibility study for the 1000 ha replanting project, this project has a period of 10 years. This feasibility study aims to ensure that the 1,000 Ha: Financially profitable replanting project within 10 years. Be competitive in the market by paying attention to CPO price trends. Within a period of 10 years, the 1,000 Ha replanting project is expected to be able to make a significant contribution to the company's revenue. Assuming stable production starting in the 4th year, as well as a gradual increase in the extraction rate of CPO, PK, and Shell, annual revenue is projected to continue to increase until it reaches the optimal point in the 10th year. This shows that large initial investments can pay off through consistent positive cash flow, making the project financially viable.

In addition, the competitiveness of this project is highly dependent on CPO price trends in the global market. Fluctuating CPO prices demand risk mitigation strategies, such as diversification of palm oil derivative products or long-term sales contracts. Taking into account the price trends and demand for CPO which tend to increase as the population grows and the demand for vegetable energy, the project has a strong market prospect. Another factor that supports feasibility is operational cost efficiency. A scalable cost structure, from harvesting,

transportation, to sales expenses, allows companies to keep profit margins healthy. When combined with modern agronomic practices and sustainable certification (ISPO/RSPO), the project is not only financially profitable, but also enhances the company's reputation in the international market. For more details, the author explains in the Table on the next page.

Table 3. Feasibility study Replanting 1000 ha

PT. Agricinal											
Studi Kelayakan Replanting 1000 Ha											
Item	**Unit**	**Projection TM1 01-Jan-26 31-Dec-26**	**Projection TM2 01-Jan-27 31-Dec-27**	**Projection TM3 01-Jan-28 31-Dec-28**	**Projection TM4 01-Jan-29 31-Dec-29**	**Projection TM5 01-Jan-30 31-Dec-30**	**Projection TM1 01-Jan-31 31-Dec-31**	**Projection TM2 01-Jan-32 31-Dec-32**	**Projection TM3 01-Jan-33 31-Dec-33**	**Projection TM4 01-Jan-34 31-Dec-34**	**Projection TM5 01-Jan-35 3 1-Dec-35**
Revenue Drivers											
x Total Area Planted	Ha	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Standard Production Project 2026	Ton/Ha				12,7	18,8	20,6	23,1	26,5	27,6	27,6
Standard Production Project	Ton				12700	18800	20600	23300	26500	27600	27600
Standard Product	Ton				10160	15040	16480	18640	21200	22080	22080
x Standard Product TM Achievement	%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%
x Production Extraction											
CPO Extraction	%	20.00%	20.00%	20.00%	20.00%	20.00%	20.00%	20.00%	20.00%	20.00%	20.00%
PK Extraction	%	5.30%	5.30%	5.30%	5.30%	5.30%	5.30%	5.30%	5.30%	5.30%	5.30%
Shell Extraction	%	4.50%	4.50%	4.50%	4.50%	4.50%	4.50%	4.50%	4.50%	4.50%	4.50%
CPO	Ton				2032	3008	3296	3728	4240	4416	4416
PK	Ton				538	797	873	988	1124	1170	1170
Shell	Ton				457	677	742	839	954	994	994
x Sales Price											
CPO	Rp/Kg	14388	14604	14824	15046	15272	15502	15735	15971	16211	16455
PK	Rp/Kg	12231	12414	12600	12789	12981	13176	13374	13574	13778	13985
Shell	Rp/Kg	740	751	762	773	785	797	809	821	833	846
x Revenue											
Total Revenue	Rp Juta				37815	56818	63194	72550	83753	88540	89869
CPO	Rp Juta				30574	45939	51094	58429	67718	71538	72664
PK	Rp Juta				6587	9898	10999	12643	14614	15425	15665
Shell	Rp Juta				354	531	591	678	783	828	840

From the table above, the following analysis is obtained: The project period is 10 years. The 1,000 Ha replanting project demonstrated strong financial viability, with revenues starting to flow in the 4th year onwards. The break-even point is reached between TM Yielding Plants 6 to TM7, depending on the accumulated costs and net income. The consistent cost structure and increased revenue suggest that the project has the potential to generate healthy margins in the long run.

Financial Feasibility Analysis

The company plans to carry out a replanting project covering an area of 1000 ha, and stipulates that 20% of the 1000 ha will be designated as an intercropping area for banana goods. The following is a table of the Cost Budget Plan (RAB) for the 1000 ha replanting project.

Table 4. RAB Garden Replanting 1000 ha

DESCRIPTION	TOTAL Rp/Ha	TOTAL Rp
INITIAL COSTS		
Land Clearing	11865731	11865731458
Road and Bridge Construction	1959083	1959083322
Parit, Terasan & Tipak Kuda Construction	7349904	7349903794
Legume Planting	2228091	2228090800
Oil Palm Planting	10378956	10378955590
SUB TOTAL	33781765	33781764964
6-MONTH MAINTENANCE COSTS		
Mounding	1067283	1067283398
Fertilizing	4760096	4760096027
Pest and Disease Control	123666	123665627
Census and Thinning Out	19246	19246456
Terracing and Consolidation	159816	159815790

Parit, Terasan & Tipak Kuda Maintenance	122957	122957472
Road and Bridge Maintenance	686916	686916384
Survey and Markers	94308	94307586
SUB TOTAL	7034289	7034288800
2nd YEAR MAINTENANCE COSTS		
Mounding	1413136	1413135933
Fertilizing	12812970	12812970448
Pest and Disease Control	252837	252837084
Castration and Sanitation	957905	957905288
Census and Thinning Out	21107	21106970
Terracing and Consolidation	116198	116197722
Ditch, Terrace & Horse Hoof Maintenance	199357	199356856
Road and Bridge Maintenance	1020726	1020725580
Survey and Markers	73744	73744154
SUB TOTAL	16848981	16848980035
3rd YEAR MAINTENANCE COSTS		
Mounding	1487504	1487503872
Fertilizing	14081047	14081046929
Pest and Disease Control	635251	635250672
Castration and Sanitation	1053181	1053180850
Census and Thinning Out	23129	23128752
Terracing and Consolidation	102058	102057690
Ditch, Terrace & Horse Hoof Maintenance	217599	217599110
Road and Bridge Maintenance	1705102	1705102394
Survey and Markers	80951	80950646
SUB TOTAL	19385821	19385820915
TOTAL DIRECT COSTS	77050855	77050854714
ALLOCATION OF INDIRECT COSTS	4049324	4049323929
GRAND TOTAL	81100179	81100178643

The following is the RAB Table for intercropping projects covering an area of 200 ha.

Table 5. RAB intercropping garden 200 ha

RAB PISANG BARANGAN					
Total Planted Area	144,000 Stalks		200 Ha TBM Area		
Survival Rate	80%		120 Ha Area of Banana Intercropping Plants		
Needs	**Category**	**Volume**	**Unit**	**Price per Unit (Rp)**	**TOTAL (Rp)**
Land Preparation	Land Clearing	120	It has	2000000	240000000
Land Processing	Opening Planting Hole	144000	Holes	5250	756000000
	Pupsawit Fertilizer	720000	Kg	100	72000000
	Dolomite	1440	Sacks	65000	93600000
				Sub-Total	1161600000
Capex	Irrigation Drip	8	Packages	67235500	537884000
	Angkong	2	Units	725000	1450000
	Stairs	2	Units	775000	1240000
	machetes, hoes, etc	6	Packages	450000	2700000
	Paranet	2000	Meters	30000	60000000
	Fence Piles	2	Wholesale	5000000	10000000
	Chokon Machine	24	Units	5500000	132000000
	Tangki Sprayer	48	Units	475000	22800000
				Sub-Total	798074000
Maintenance	Tissue Cultured Banana Seeds	160000	Stalks	13000	2080000000
	Seed Quarantine	8	Units	5000000	40000000
	Cost of Seeding	160	Days	18000	2880000
	Seed Sowing Workforce	160000	Stalks	300	48000000
	Hi	3200	Sacks	18000	38400000
				Sub-Total	2209280000
Fertilizer	Yaramila Fertilizer 16.16.16 Unique Ages 1, and 2 BST	100	Gram/Stalk	17	1468800000
	Fertilizer Yaramila Winner 15.09.20 (5) Ages 4, 6 and 8 BST	200	Gram/Stalk	18	1555200000
	Yaramila Complex Fertilizer 12.11.18 Ages 9, and 10 BST	200	Gram/Stalk	20	4032000000
	Scotland's 4 p.m.	800	Stalks	550000	880000000
	Labour Force Measures Infection	640	HK	100000	128000000
	Dblh Watering	800	Liters/Month	13000	301600000
	Pesticides	8	Application/Month	850000	163200000
	Herbisida	40	Gallons/3 Months	1050000	378000000
				Sub-Total	8906800000

Harvest	Bagging Fee	144000	Pcs	2500	360000000
	Shipping Expeditions	64	Expeditions/Months	3000000	3264000000
				Sub-Total	3624000000
				TOTAL	16669754000

The author has simulated a *plan of replanting* 1000 ha vs *replanting* 1000 with intercropping of banana goods. From the table above, the following analysis is obtained: The project period is 10 years. The 1,000 Ha replanting project shows strong financial viability, with income starting to flow TBM2, TBM 3 or so-called 2nd and 3rd years from banana plants, and from oil palm starting from TM 1 onwards, or 4th year onwards. The consistent cost structure and increased revenue suggest that the project has the potential to generate healthy margins in the long run. Here is a summary table.

Table 6. Summary of business feasibility

Project Comparison and Investment Analysis			
Description	**1. Replanting 1,000 Ha**	**2. Replanting 1,000 Ha & Intercropping Banana 120 Ha**	**Variant: 2 - 1**
I. Company Name	PT Agricinal	PT Agricinal	
II. Project Type	1. Replanting 1,000 Ha	2. Replanting 1,000 Ha & Intercropping Banana 120 Ha	
III. Study Purpose and Objectives	Study the viability of Replanting 1,000 Ha	Study the viability of the Replanting 1,000 Ha project with Intercropping Banana 15 Ha per Block 25 Ha	
IV. Investment Credit Needs			
Source of Funding:			
- Own Capital	Rp 81,122,928,132	Rp 97,792,682,132	Rp 16,669,754,000
Time Period	10 Years	10 Years	
Business Viability:			
- Net Present Value (NPV)	Rp 58,629,127,936	Rp 91,508,974,865	Rp 32,879,846,929
- Internal Rate of Return (IRR)	24.8%	44.7%	19.9%
- Benefit - Cost Ratio (B/C Ratio)	1.653	1.773	0.120
- Payback Period	6 Years 0 Months	4 Years 0 Months	-2 Years 0 Months

Net Present Value (*NPV)*

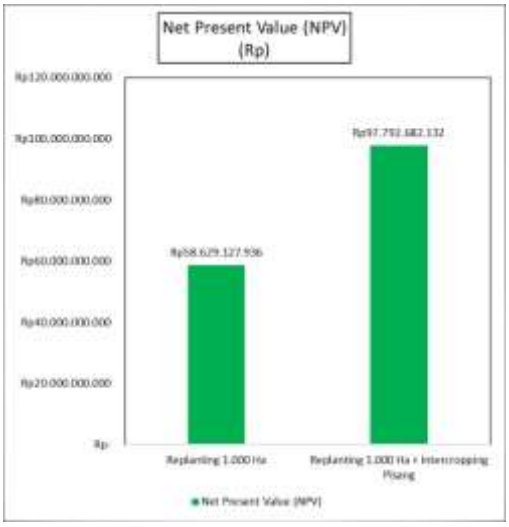

Figure 2. NPV

The simulation results show that the scenario of replanting 1,000 ha without intercropping produces an NPV of Rp 58,629,127,936 Meanwhile, the scenario with

intercropping of Bananas produces an NPV of Rp 97,792,682,132 An increase of Rp 39.16 billion or 66.8% shows that intercropping has a significant financial impact. The calculation results in Figure 5 show that the replanting scenario without intercropping produces an NPV of Rp 58,629,127,936.00 which is in the positive but relatively low value range. This value reflects that the project is still viable, but the profit margin is limited due to the absence of revenue during the Crop Not Producing (TBM) period. On the other hand, the scenario of replanting with intercropping of Bananas produces an NPV of Rp 97,792,682,132 compared to the scenario without intercropping. This increase was mainly due to the additional cash flow from banana sales during the 1st to 3rd years, which was able to close the income gap from palm oil. This finding is in line with the research of Erlina (2006) and Rantala (2009) who stated that crop diversification can increase the economic value of land during non-productive periods.

NPV Chart Analysis

Comparison of Scenarios The graph shows two scenarios of oil palm replanting covering an area of 1,000 Ha: Scenario 1: Replanting 1,000 Ha, NPV: Rp 58,629,127,936, Scenario 2: Replanting 1,000 Ha + Intercropping Bananas, NPV: Rp 97,792,682,132

NPV Value Interpretation: NPV is a key indicator of financial viability. The higher the NPV, the more profitable the project will be. The banana intercropping scenario produces a higher NPV of IDR 39.16 billion than ordinary replanting. This shows that intercropping Banana Goods significantly increases the profitability of the project.

Strategic Implications: Intercropping provides additional cash flow in the early years before oil palms are fully produced. This strategy accelerates break-even points and improves land efficiency. Suitable for investors who want faster returns and lower risk.

***Internal Rate of Return* (IRR)**

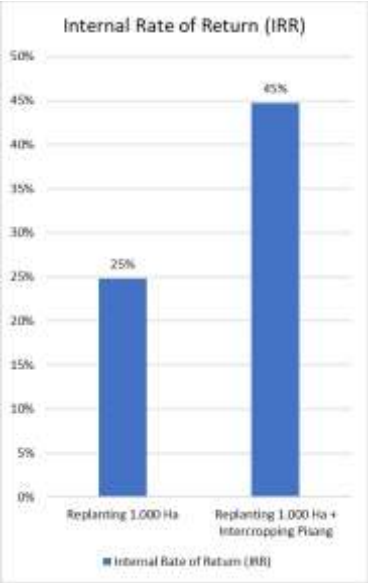

Figure 3. IRR

The IRR in the monoculture scenario was recorded at 25%, while in the intercropping scenario it increased to 45%. This increase indicates much higher investment efficiency and accelerates returns on capital. In the non-overlapping scenario, the IRR is recorded at 25%, just slightly above the discount rate used in the analysis. This indicates that the rate of return on

investment is relatively moderate and sensitive to changes in costs or selling prices. Meanwhile, the intercropping scenario shows an IRR of 45%, much higher than the monoculture scenario. This significant IRR value indicates that the integration of Pisang Barangan is able to increase investment efficiency and accelerate capital returns. Thus, the hypothesis that intercropping increases the financial viability of plantation businesses is acceptable.

IRR Chart Analysis

Scenario Comparison: Replanting 1,000 Ha: IRR of 25%, Replanting 1,000 Ha + Intercropping Bananas: IRR increases significantly to 45%, IRR is an indicator of the expected annual return on investment rate of a project. The higher the IRR, the more attractive the project is to investors because it shows greater profit potential. The IRR of 25% is already considered feasible for the agribusiness sector, but 45% shows very high investment attraction.

Strategic Implications The addition of intercropping Bananas provides additional cash flow at the beginning of the year, thereby accelerating capital returns. This strategy improves land efficiency and productivity, as well as reducing the single risk of oil palm. Suitable for investors who want quick and stable returns, especially in the first 5 years of the project.

Net Benefit-Cost Ratio (Net B/C)

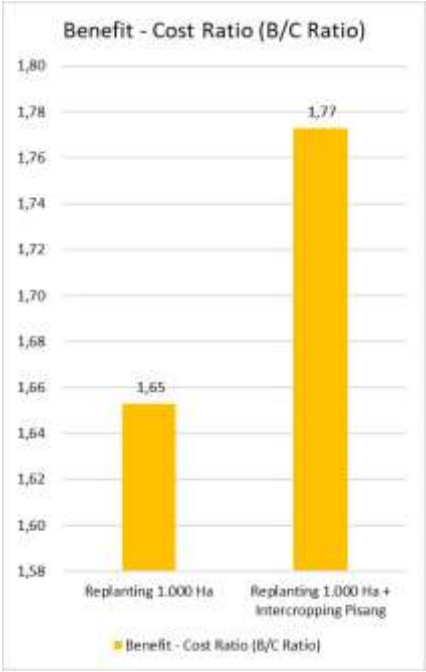

Figure 4. Net Benefit Cost Ratio

The monoculture scenario yields a Net B/C of 1.65, while the intercropping reaches 1.77. This increase in ratio shows that every Rp 1 cost results in a net benefit of Rp 1.77, strengthening the economic viability of the intercropping strategy. In the intercropping scenario, the Net B/C increases to 1.77 which means that the net benefit obtained is much greater than the costs incurred. This increase reinforces the argument that intercropping provides significant financial leverage during the replanting period.

B/C Ratio Chart Analysis

Comparison of 1,000 Ha Replanting Scenario: B/C Ratio of 1.65 Replanting 1,000 Ha + Banana Intercropping: B/C Ratio increased to 1.77. B/C Ratio B/C Ratio shows the economic efficiency of a project: how much benefit is obtained compared to the costs incurred. A value of >1 indicates that the project is economically viable. The higher the B/C Ratio, the more

efficient and profitable the project will be.

Strategic Implications The addition of intercropping Banana Goods increases the total benefits without increasing costs proportionately. This strategy maximizes land utilization and initial cash flow, thereby increasing investment efficiency. Suitable for companies that want to optimize ROI and accelerate return on capital.

Payback Period

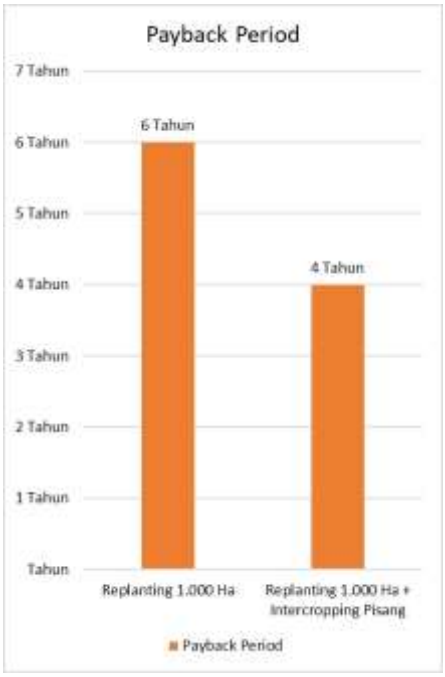

Figure 5. *Payback* Period

The no-overlap scenario has a Payback Period of 6 years, which is relatively long due to the absence of revenue during the TBM period. This condition has the potential to cause pressure on the company's cash flow. In contrast, the overlapping scenario shows a shorter Payback Period, which is 4 years. This happens because income from Banana Barangan has started to come in since the first year, thus accelerating investment recovery. Thus, the hypothesis that intercropping accelerates returns is proven to be acceptable.

Payback Period Chart Analysis

Comparison Scenarios, Replanting 1,000 Ha: Payback period for 6 years, Replanting 1,000 Ha + Intercropping Bananas: Payback period is faster, which is 4 years. Payback period indicates how long it takes to return the initial investment through cash flow. The shorter the payback period, the faster the investor will regain the invested capital. The 2-year difference between the two scenarios is particularly significant in the context of agribusiness, which generally has a long investment cycle. Strategic Implications of Intercropping Bananas Goods provide additional income in the early years, thereby accelerating the return on capital. This strategy reduces investment risk and increases the attractiveness of projects for investors who prioritize liquidity and capital efficiency. Suitable for companies that want to maintain healthy cash flow and accelerate business expansion or diversification.

Sensitivity Analysis

Sensitivity analysis was conducted to test the resilience and financial feasibility of the project to changes in key variables that are dynamic and uncertain. In the context of the 1,000

Ha replanting project with intercropping of Bananas Goods, the main variables analyzed include: CPO selling price, Banana Goods selling price, Annual operational costs, FFB production rate, CPO extraction rate

Sensitivity to CPO Prices, CPO Prices have a dominant influence on project revenue. The simulation was carried out with a scenario of decreasing and increasing CPO prices by ±10% of the base price. The results showed that: A 10% decrease in CPO prices led to a decrease in NPV of up to 18% and a drop in IRR to 38%. A 10% increase in CPO prices increased NPV by 22% and IRR increased to 49%.

Sensitivity to Operating Costs, Increased operating costs can erode profit margins. The simulation was carried out with a scenario of a 15% increase in costs. The result: NPV decreased to IDR 82.4 billion. IRR dropped to 41%. The payback period shifted from 4 years to 5 years.

Sensitivity to FFB Production, FFB Production is greatly influenced by agroclimatic conditions and plantation management. If production drops by 10% from the standard projection: NPV drops to IDR 85.6 billion. The IRR dropped to 42%. The payback period remains at 4 years, but the profit margin decreases.

Sensitivity to Banana Prices of Goods, Intercropping of Bananas Goods made a significant contribution to initial cash flow. If the selling price of bananas drops by 20%: NPV drops to IDR 91.2 billion. The IRR dropped to 43%. The payback period remains at 4 years, indicating that the project remains viable despite price pressures.

SWOT Analysis

SWOT analysis was used to identify strengths, weaknesses, opportunities, and threats that affected the success of the 1,000 Ha replanting project with the Pisang Goods intercropping strategy.

Strengths , Income diversification: Intercropping Banana Goods provides additional cash flow at the beginning before oil palm is fully produced. High NPV and IRR: The project shows strong financial viability with an IRR of 45% and an NPV of nearly IDR 100 billion. Land efficiency: Land use is more optimal with a combination of oil palm and banana plants. Faster payback period: The return on capital is only 4 years, shorter than conventional replanting.

Weaknesses , Dependence on commodity prices: Fluctuations in CPO and banana prices can affect profitability. More complex operational costs: Managing two commodities at once requires more labor, logistics, and management. Technical risks of intercropping: Potential for more complex nutrient competition and agronomic management.

Opportunities , Global CPO market demand: The trend of growing demand for vegetable oil and renewable energy continues to increase. Domestic and export banana market: Bananas have a wide market potential, both locally and internationally. Continuous certification (ISPO/RSPO): Provides added value and premium market access. Government policy support: People's oil palm replanting program and sustainable agribusiness incentives.

Global price fluctuations: A decline in CPO or banana prices can squeeze profit margins. Climate and pest risks: Extreme weather changes, plant disease infestations, and pests can decrease productivity. Strict regulation: Changes in environmental or international trade policies may affect market access. Market competition: Competition from other CPO and banana producers, both domestic and global.

Hypothesis Test

Based on the results of the analysis of financial feasibility, sensitivity, revenue projections, and strategies, the six hypotheses that have been formulated in Table 6 are tested as follows:

1) H1 – Financial Feasibility, this hypothesis states that the application of intercropping

of Bananas on oil palm replanting land is financially feasible. **Accepted**. The simulation results show that the intercropping scenario produces an NPV of IDR 97.79 billion and an IRR of 45%, much higher than the monoculture scenario. Net B/C also increased to 1.77 and Payback Period decreased to 4 years. All indicators show that the intercropping project is financially viable.

2) H2 – Sensitivity Analysis, this hypothesis tests the resilience of the project to changes in key variables such as price, cost, and production output. **Accepted**. Sensitivity simulations show that the intercropping scenario is more resistant to declining CPO prices, rising fertilizer costs, and delayed harvest. The project remains viable despite fluctuations, showing that this strategy has good resilience to business risks.
3) H3 – Projected Revenue This hypothesis states that intercropping can increase revenue projections during the TBM period. **Accepted**. Revenue from Bananas began to come in from the first year, filling the cash flow gap that usually occurs during the initial 3-4 years of replanting. This has been proven to increase total operating income and strengthen the company's financial position.
4) H5 – Feasibility This hypothesis concludes that the intercropping strategy is feasible to implement based on the results of the quantitative analysis. **Accepted**. All financial feasibility indicators (NPV, IRR, Net B/C, PP) showed very positive results. Therefore, the intercropping strategy is declared feasible to be implemented on a wide scale.
5) H6 – Income Optimization Strategy This hypothesis states that intercropping is an effective strategy to optimize plantation business income. **Accepted**. This strategy not only increases income, but also strengthens land efficiency and cash flow resilience.

Recommendations for Intercropping Implementation Based on the results of hypothesis testing, it is recommended that PT Agricinal implement intercropping of Bananas in a replanting area of at least 120–200 ha. This strategy has proven to be financially viable, risk-resistant, and makes a significant contribution to revenue optimization during the replanting period.

CONCLUSION

Based on comprehensive technical, financial, market, and risk analyses, the 1,000-ha oil palm replanting project incorporating *Barangan* banana intercropping emerges as a highly feasible and strategic alternative. Key findings highlight its financial viability, with an NPV of IDR 97.8 billion, IRR of 45%, net B/C ratio of 1.77, and a 4-year payback period—all markedly superior to conventional replanting—while accelerating cash flows during the *Tanaman Belum Menghasilkan* (TBM) period, boosting profitability, and enhancing business competitiveness. The strategy leverages strong market demand for both CPO and bananas (domestically and for export), promotes revenue diversification, improves land use efficiency, and aligns with sustainability certifications like ISPO and RSPO, ensuring long-term operational and environmental prospects. For future research, researchers could expand this model by conducting multi-year field trials across diverse agroecological zones in Indonesia to validate scalability, assess long-term soil health impacts, and integrate climate resilience factors such as drought-tolerant banana varieties.

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