

BIOLOGICAL ASSET INTENSITY AND CPO PRODUCTIVITY AS DETERMINANTS OF FIRM VALUE: EVIDENCE FROM LISTED PLANTATION FIRMS IN INDONESIA (2019–2024)

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This study examines the determinants of firm value in the Indonesian palm oil plantation sector, focusing on the role of biological asset intensity and crude palm oil productivity. The background of this research lies in the strategic importance of the plantation industry and the need to understand how internal operational factors influence market valuation under dynamic economic conditions. The study uses secondary data derived from annual financial statements of 12 plantation companies listed on the Indonesia Stock Exchange over the period 2019–2024, resulting in 72 observations. A quantitative approach is applied using panel data regression analysis to evaluate the relationships between variables. The results reveal that biological asset intensity has a negative and statistically significant effect on firm value, indicating that higher proportions of such assets may increase earnings volatility and perceived risk, thereby reducing investor confidence. In contrast, crude palm oil productivity shows a positive and significant effect, suggesting that improved operational efficiency enhances financial performance and firm valuation. Simultaneously, both variables significantly influence firm value, with the model explaining a moderate proportion of variation. In conclusion, firm value in the plantation sector is not solely determined by the scale of biological assets but by the efficiency of their utilization. Enhancing productivity is crucial for value creation, while effective asset management is necessary to mitigate associated risks and sustain investor confidence.

Keywords: *Biological Asset, CPO Productivity, Firm Value, Plantation, Data Panel*

1. INTRODUCTION

The palm oil plantation sector plays a strategic role in Indonesia's economy as a major contributor to foreign exchange and a key component of the agribusiness value chain. Plantation companies listed on the Indonesia Stock Exchange (IDX) are required to enhance firm value as a reflection of their performance and future prospects. In this industry, biological assets constitute the dominant portion of total assets and are directly linked to the production capacity of crude palm oil (CPO). However, the relationship between biological asset intensity and firm value is not always linear, as ineffective asset management, production uncertainty, commodity price volatility, and external shocks such as the COVID-19 pandemic and policy changes may weaken financial performance (Lee et al., 2014; Mujiani et al., 2022; L. P. Sari & Wijaya, 2022).

Biological asset intensity, defined as the proportion of biological assets to total assets, theoretically reflects a firm's production potential. A higher intensity suggests greater capacity to generate output and revenue. Nevertheless, empirical evidence indicates that increasing biological asset intensity without effective management may reduce firm performance and value due to risks such as climate change, productivity uncertainty, and fluctuating CPO prices (Lee et al., 2014; D. W. Sari et al., 2021; Setiahutami & Chalid, 2024). In addition, the implementation of PSAK 241 on biological asset reporting highlights the importance of transparency and fair value measurement, which can influence investor perception and indirectly affect firm value through improved information quality (Langkau et al., 2022; Mujiani et al., 2022).

CPO productivity represents a critical operational indicator that reflects the efficiency of biological asset utilization. Higher productivity indicates the firm's ability to optimize land, crop yield, and agronomic practices, thereby enhancing financial performance and strengthening firm value. From

a signaling perspective, productivity serves as a positive signal to investors regarding managerial capability and future growth potential. However, its impact on firm value remains context-dependent, as it is influenced by external factors such as global price volatility, biodiesel policies, and market dynamics (D. W. Sari et al., 2021; Rifin et al., 2020; Setiahutami & Chalid, 2024).

Empirical evidence within the palm oil industry also reveals that large biological asset holdings do not guarantee higher firm value if they are not supported by high productivity, cost efficiency, and strong corporate governance. Several plantation companies have experienced financial distress, operational restructuring, or partial shutdowns due to high debt burdens, declining productivity, and operational inefficiencies (D. W. Sari et al., 2021; Lee et al., 2014; Putri et al., 2019). Furthermore, the 2019–2024 period is characterized by significant external dynamics, including the COVID-19 pandemic, global CPO price fluctuations, and evolving trade and energy policies, which further complicate the relationship between biological asset intensity, productivity, and firm value (Qudsi et al., 2020; Rifin et al., 2020). Therefore, this study aims to re-examine the role of biological asset intensity and CPO productivity as determinants of firm value in plantation companies listed on the IDX within this dynamic context.

2 LITERATURE REVIEW

This study integrates three major theoretical frameworks signaling theory, agency theory, and the resource-based view (RBV) to explain how biological assets and operational productivity contribute to firm value. Signaling theory posits that information disclosed by firms serves as a signal to investors regarding performance and future prospects, thereby reducing information asymmetry and enhancing market confidence (Khodijah & Utami, 2021; Ramakrishnan et al., 2020; Rezensky & Lukman, 2023). In the context of biological assets, transparent disclosure regarding asset valuation, quantity,

and associated risks strengthens positive market perceptions of a firm's capacity to generate revenue. Meanwhile, agency theory highlights the potential conflict of interest between managers (agents) and shareholders (principals), which may give rise to agency costs; thus, effective corporate governance and transparent reporting of biological assets are essential to mitigate opportunistic behavior and preserve firm value (Damanik & Rahayu, 2021; Nasirwan et al., 2026, Rezensky & Lukman, 2023; Khodijah & Utami, 2021).

The integration of these three theories suggests that RBV serves as the primary framework for explaining value creation through internal resource management, while signaling theory explains how this value is communicated to the market, and agency theory provides the governance mechanisms ensuring effective and accountable resource utilization (Golder et al., 2017; Msomi, 2023). Accordingly, in firms characterized by biological asset intensity, firm value is not solely determined by the magnitude of assets but also by the firm's ability to enhance productivity, deliver credible information to the market, and implement sound governance practices. Therefore, this study positions biological asset intensity and productivity as key determinants of firm value, while acknowledging that reporting quality, ownership structure, and external factors such as ESG considerations and market conditions may moderate these relationships, offering a more comprehensive understanding of firm value dynamics in resource-based industries (Moyini et al., 2025; Ramakrishnan et al., 2020).

Based on theoretical review and prior empirical studies, it can be understood that biological asset intensity and CPO productivity are key determinants in shaping firm value in the plantation sector. Biological asset intensity reflects production capacity, while CPO productivity represents the efficiency of utilizing those assets. The combination of both determines a company's ability to generate revenue and improve financial performance.

However, this relationship is influenced by external factors such as CPO price volatility and macroeconomic conditions, as well as internal factors such as corporate governance. Therefore, this study proposes the hypotheses that biological asset intensity affects firm value, CPO productivity has a positive effect on firm value, and both variables simultaneously influence firm value in plantation companies listed on the Indonesia Stock Exchange.

Based on the theoretical review and previous research results, this research model can be constructed as shown in Figure 2.1.

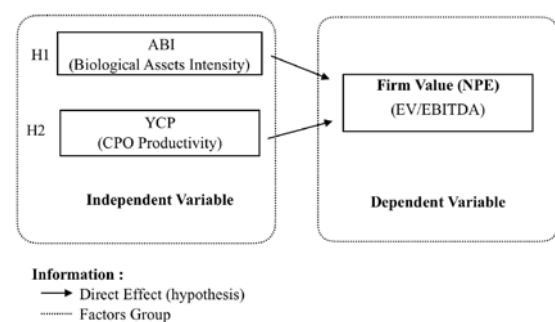


Figure 2.1 Research Model

3 METHODS

This study employs a quantitative research approach aimed at analyzing the effect of biological asset intensity and CPO productivity on firm value in the palm oil plantation sector. The data used in this study are secondary data obtained from plantation companies listed on the Indonesia Stock Exchange (IDX). The sample consists of 12 companies selected using purposive sampling criteria, with an observation period covering six years from 2019 to 2024. This period is chosen based on data availability and its relevance in capturing the dynamic conditions of the plantation industry.

The data sources in this study include annual financial statements published by the companies, accessed through the official IDX website as well as the respective company websites, and supporting data obtained from Bloomberg. The financial statements are used to collect information related to the research variables, such as biological assets, total assets, and other

financial indicators, while Bloomberg data are utilized to complement market-related information and ensure the consistency and reliability of the dataset.

Operational Variables

The operational definition of this research variable consists of two independent variables and one dependent variable which will be explained below:

Table 3.1 Operational Variable

No	Variable Definition/Indicator
1	Biological assets intensity (ABI) is the ratio between the carrying value of biological assets and total assets. ABI=biological assets value/total assets
2	CPO productivity (YCP) is the amount of CPO produced per hectare from oil palm plantations. YCP=yield fresh fruit bunch (FFB) x CPO extraction (%)
3	Firm Value (NPE) is an indicator of a company's overall performance. It reflects the returns that investors may expect to receive based on the investments they have made. NPE = Market Capitalization (share price x number of outstanding shares) + Total Debt – Cash and Cash Equivalents EBITDA = Operating Profit (EBIT) + Depreciation + Amortization

The research model used in this analysis is panel data regression, which combines time series data (2019-2024) and cross-sectional data (12 companies). The model equation is as follows:

$$NPE_{it} = \alpha + \beta_1 ABI_{it} + \beta_2 YCP_{it} + \varepsilon_{it}$$

Description:

NPE_{it} = Firm Value (EV/EBITDA) of company i in period t

ABI_{it} = Biological Asset Intensity

YCP_{it} = CPO Productivity

α = constant

β_1, β_2 = regression coefficients

ε_{it} = error term

Data processing is conducted using Eviews software, including model selection procedures among common effect, fixed effect, and random effect models, as well as classical assumption tests to ensure the validity of the estimation results. Through this approach, the study aims to provide robust empirical evidence on the relationship between biological asset intensity, CPO productivity, and firm value in the Indonesian plantation sector.

4. RESULTS

Descriptive Analysis

The results of the descriptive analysis can be seen in Table 1.

Table 4.1. Descriptive Analysis

	YCP	NPE	ABI
Mean	3.8620	6.0786	0.0194
Median	3.8084	5.0404	0.0154
Maximum	5.9801	14.431	0.0729
Minimum	2.3316	0.3515	0.0041
Std. Dev.	0.7404	3.7249	0.0151
Skewness	0.2638	0.7801	2.0665
Kurtosis	2.6653	2.9106	6.9658
Jarque-Bera	1.1711	7.3285	98.432
Probability	0.5567	0.0256	0.0000
Sum	278.06	437.66	1.3993
Sum Sq. Dev.	38.925	985.13	0.0163
Observations	72	72	72

Source : EViews data analysis.

The descriptive statistical analysis of 72 observations indicates that Firm Value (NPE) has a mean of 6.0786 and a median of 5.0404, with a range from 0.3515 to 14.4312 and a standard deviation of 3.7249, which is lower than the mean, suggesting a relatively even data distribution; Biological Assets (ABI) have a mean of 0.0194 and a median of 0.0154, with values ranging from 0.0041 to 0.0729 and a standard deviation of 0.0151, indicating a fairly homogeneous distribution; meanwhile, CPO Productivity (YCP) shows a mean of 3.8620 and a median of 3.8084, with a range of 2.3316 to

5.9801 and a standard deviation of 0.7404, reflecting relatively low and stable variability. In terms of distribution, the Jarque-Bera test reveals that only YCP is normally distributed (probability $0.5567 > 0.05$), while NPE (0.0256) and ABI (0.0000) are not fully normally distributed, a condition commonly found in panel data.

Classical Assumptions

The evaluation of classical assumptions demonstrates that the regression model does not encounter multicollinearity, as evidenced by the Centered VIF values of the independent variables (ABI and YCP), all of which are substantially below the critical limit of 10, indicating their adequacy within the model. However, the heteroskedasticity test results suggest a violation of the constant variance assumption, with a probability value of 0.0159 that falls below the 5% significance level, confirming the existence of heteroskedasticity in the initial model specification. Moreover, the Durbin-Watson statistic, recorded at 0.815887, signals a likelihood of autocorrelation. To mitigate these issues, the estimation is refined using the Panel EGLS method with cross-section weights, which effectively accounts for heteroskedasticity and yields more efficient estimators accompanied by robust standard errors. Consequently, the adjusted model meets the BLUE criteria and can be considered dependable for subsequent hypothesis testing.

Regression Model

The results of the panel data model selection procedures indicate that the Chow test generates a cross-section F probability of 0.1860, which exceeds the 0.05 significance level, implying that there is no meaningful difference between the common effects and fixed effects models; thus, the common effects model is preferred over the fixed effects alternative. In addition, the Hausman test shows a probability value of 0.4356, also above 0.05, suggesting that the random effects model provides more consistent estimates compared to the fixed effects model, and is therefore more appropriate. To reinforce

this decision, the Lagrange Multiplier (Breusch-Pagan) test yields a probability of 0.0000, which is below the 5% threshold, indicating that the random effects model is significantly superior to the common effects model. Taken together, these findings consistently support the use of the random effects model, as it is more effective in capturing both cross-sectional and temporal variations within the data.

Estimation and Interpretation of the Regression Equation

Regression models are used to determine the positive or negative direction of the influence of the independent variables on the dependent variable. The results obtained are listed in Table 4.2.

Table 4.2. Regression Parameters and t-Test

Variable	Coefficient	Std. Error
ABI	-96.35331	19.88988
YCP	2.086295	0.417937
C	-0.106075	1.827014

Variable	t-Statistic	Prob.
ABI	-4.844339	0.0000
YCP	4.991892	0.0000
C	-0.058059	0.9539

Source : EViews data analysis.

The interpretation of the regression output primarily emphasizes the statistical significance of each independent variable in explaining the dependent variable. The ABI variable shows a coefficient of -96.35331, accompanied by a t-statistic of -4.844339 and a probability value of 0.0000, which is substantially lower than the standard significance level ($\alpha = 0.05$). This finding confirms that ABI exerts a negative and statistically significant influence on the dependent variable. Consequently, the proposed hypothesis regarding the effect of ABI is supported. From an econometric standpoint, the high absolute value of the t-statistic reinforces the robustness of this relationship, indicating that the observed effect is systematic rather than driven by random variation. In practical terms,

an increase in ABI is associated with a significant decline in the dependent variable with a high degree of certainty.

In contrast, the YCP variable yields a coefficient of 2.086295, with a t-statistic of 4.991892 and a probability value of 0.0000 (below 0.05). These results demonstrate that YCP has a positive and statistically significant impact on the dependent variable. Similar to the ABI findings, the extremely low p-value highlights the strength and reliability of this effect, suggesting that it can be generalized beyond the sample. Therefore, the hypothesis asserting the influence of YCP is also accepted. Practically, this implies that an increase in YCP contributes to a significant rise in the dependent variable, underscoring its relevance in explaining variations within the model.

Overall, the regression analysis indicates that both ABI and YCP are highly significant predictors (p-value < 0.01) and serve as key determinants in the model. The contrasting signs of their coefficients reveal differing roles, where ABI functions as a diminishing factor, while YCP acts as an enhancing factor for the dependent variable. Thus, the model effectively captures the relationship between the explanatory variables and the dependent variable, particularly in terms of their statistical significance and directional impact.

The model fit test, or simultaneous test of the influence of independent variables on the dependent variable, is shown in Table 4.3.

Table 4.3. The Model Fit Test (F-Test)

R-squared	0.400277
Adjusted R-squared	0.382894
S.E. of regression	2.517596
F-statistic	23.02658
Prob(F-statistic)	0.000000

Source : EVIEWS data analysis.

The estimation results show that the F-statistic is 23.02658, with a Prob(F-statistic) of 0.000000, which is substantially lower than the

conventional significance threshold ($\alpha = 0.05$). This finding leads to the rejection of H_0 and acceptance of H_1 , indicating that all independent variables in the model—ABI and YCP—jointly exert a statistically significant influence on the dependent variable (NPE).

These results suggest that the regression model is significant overall and possesses adequate capability in capturing the relationship between the explanatory variables and the dependent variable. In other words, ABI and YCP collectively contribute meaningfully to explaining the variation in NPE, thereby supporting the model's relevance for analytical and decision-making purposes.

The coefficient of determination (R^2) of 0.400277 implies that approximately 40.03% of the variability in NPE can be accounted for by ABI and YCP within the model, while the remaining 59.97% is attributed to other factors not included in the analysis.

Moreover, the Adjusted R^2 value of 0.382894 indicates that, after considering the number of predictors and sample size, the model is able to explain about 38.29% of the variation in NPE. The relatively small difference between R^2 and Adjusted R^2 suggests that the model is fairly stable and does not exhibit signs of overfitting.

Overall, the explanatory power of the model can be categorized as moderate. While it captures a substantial portion of the dependent variable's variation, a considerable share remains influenced by variables beyond the scope of this study. Therefore, future research is encouraged to incorporate additional relevant determinants in order to enhance the model's explanatory strength.

Discussion

Based on the overall discussion, it can be concluded that biological asset parameters in oil palm plantations have a significant but negative effect on firm value, indicating that an increase in the value or proportion of biological assets is

not necessarily responded to positively by the market. This finding reflects the complex nature of the relationship between biological assets and firm value, particularly due to the application of fair value measurement as regulated under PSAK 241. The use of fair value tends to increase volatility in earnings and equity because of revaluation adjustments that are highly sensitive to changes in commodity prices, production costs, and other external factors. This condition leads to short-term instability in financial performance, causing investors to perceive higher risk, which ultimately puts downward pressure on firm value. Thus, although biological assets provide more relevant accounting information, their impact on market perception is not always favorable.

These findings are consistent with several previous studies showing that fair value measurement of biological assets can negatively affect firm value under certain conditions. Studies by Aziz et al., 2023; Daulay et al., 2024; Langkau et al., 2022 indicate that changes in the fair value of biological assets can create significant earnings volatility and lead to a decline in firm value. Furthermore, Gunawan et al., 2022 and Ramadhan et al., 2024 emphasize that although biological assets are a key component in the oil palm industry, their impact on firm value is often mediated by other factors such as profitability, liquidity, and leverage. International studies such as Abdullah et al., 2018, also highlight that differences in measurement methods (historical cost versus fair value) can lead to varying impacts on financial performance and firm value. Therefore, this study reinforces the literature that the relationship between biological assets and firm value is not linear, but rather influenced by accounting dynamics, market conditions, and investor risk perceptions.

Based on the overall analysis, it can be inferred that CPO productivity exerts a significant and positive influence on firm value, suggesting that increased productivity plays a crucial role in driving value creation within palm

oil companies. From both theoretical and empirical perspectives, higher productivity indicated by improved fresh fruit bunch (FFB) yields, greater production output, and increased CPO yield contributes to higher revenues, enhanced operational efficiency, and stronger cash flow generation. These factors ultimately improve financial performance, as reflected in key indicators such as ROA, ROE, and firm value, which are positively interpreted by investors and translated into higher stock prices and overall firm value. Consequently, CPO productivity functions not only as a measure of operational effectiveness but also as an important market signal reflecting the company's future growth potential and long-term sustainability.

These findings are consistent with several previous studies that confirm a positive relationship between productivity and firm value. Research by Febriansyah (2023), shows that improvements in operational performance and profitability directly contribute to increased firm value. In addition, Irawan & Soesilo (2021) and Kusuma & Noor (2024), find that productivity and global CPO prices positively affect financial performance and firm value, although the relationship may be influenced by external factors such as government policies and macroeconomic conditions. Other studies, such as Rosyidasari & Iftadi, 2020; Sucipto & Assomadi, 2023) emphasize that improvements in production efficiency and downstream integration can enhance value added and competitiveness, ultimately strengthening firm value in the market. Therefore, this study reinforces the literature that CPO productivity is an important determinant in increasing firm value, particularly when supported by operational efficiency and appropriate business strategies.

5. CONCLUSION AND SUGGESTION

The conclusions drawn from this study are as follows:

1. Biological asset parameters have a significant but negative effect on firm value in palm oil companies listed on the IDX, indicating that increases in biological asset values may raise earnings volatility and perceived risk, thereby reducing firm value.
2. CPO productivity has a significant and positive effect on firm value in palm oil companies listed on the IDX.
3. Higher CPO productivity, reflected in increased FFB yield, production volume, and CPO output, contributes to improved financial performance and ultimately enhances firm value.

Research Limitations

This study has several limitations. First, the sample is limited to palm oil companies listed on the IDX, so the results may not be generalized to other sectors or regions. Second, the study only uses biological assets and CPO productivity as independent variables, while other important factors such as macroeconomic conditions and corporate governance are not included. Third, the use of secondary data from financial statements may not fully capture qualitative aspects such as managerial decisions and operational strategies.

Recommendations

For future research, it is recommended to expand the sample by including more companies, longer periods, or different sectors to obtain more comprehensive results. Further studies should also consider adding other variables such as macroeconomic factors, corporate governance, and sustainability aspects. In addition, using more advanced analysis methods or combining quantitative and qualitative approaches is suggested to better understand the relationship between variables.

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