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Economic Efficiency of Smallholders Oil Palm Plantations in Lubuk Barumun District Padang Lawas Regency, North Sumatera

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Abstract
This study was conducted to analyse the economic efficiency of smallholder oil palm plantations and the socioeconomic factors that affect them. The study area was purposively selected because it is the sub-district with the largest area of smallholder oil palm plantations in Padang Lawas Regency, with the largest area of smallholder oil palm plantations on the West Coast of North Sumatra Province. The study sample was determined using quota sampling, with 150 samples drawn from Aek Lancat Village and Pagaran Mompang Village, each with 75 samples. Data analysis methods used: Data Envelopment Analysis and Censored Tobit Regression Analysis for smallholder oil palm plantation management data for 2023. The results showed that the majority (85.33%) of smallholder oil palm plantations were not economically efficient, with an average economic efficiency value of 0.8789. Factors such as gender, farming experience, family size, type of seed used, distance from the farmer's residence to the input market, and experience in applying organic fertiliser significantly affected the economic efficiency of smallholder oil palm plantations. Meanwhile, socioeconomic factors such as age, education, the number of productive oil palm plants cultivated, access to credit, experience in participating in farmer organisations, and farmers' experience in using information and technology facilities related to farming management have no significant effect on the economic efficiency of smallholder oil palm plantations.

Keywords: Economic Efficiency, Smallholder Oil Palm Plantations, Socioeconomic Factors

Introduction

Oil palm has become the most prominent plantation commodity, making a significant contribution to Indonesia's economic activity. That is because the vegetable oil produced from oil palm fruit can be processed into essential materials, both in the form of semi-finished products and finished products, by the industrial sector (agro-industry). Indonesia is currently the world's largest producer of palm oil. Data from 2022 shows that oil palm plantations in Indonesia cover 16.38 million hectares, with a production level reaching 46.8 million tons of CPO. The palm oil business plays a significant role in the national economy, as evidenced by various aspects, including the employment of over 16 million workers. The palm oil agro-industry has also endeavoured to create energy independence, using biodiesel as a substitute for fossil fuels, reaching 9.3 million tons in 2020, and as a source of electrical energy, at 1,829 MW. The palm oil agribusiness will

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continue to be a key contributor to Indonesia's trade balance performance, accounting for 13.50% of non-oil and gas exports or 3.50% of Indonesia's total GDP (Kementerian Pertanian, 2022).

The types and status of oil palm plantations in Indonesia include large state-owned plantations, large private plantations, and smallholder plantations. Data from the Direktorat Jenderal Perkebunan (2024) indicate that the total area of oil palm plantations in Indonesia in 2023 was 15,435,656 hectares, comprising 40.76% smallholder plantations, 3.53% large state-owned plantations, and 55.71% large private plantations. In the future, smallholder oil palm plantations are projected to account for the largest area of oil palm plantations in Indonesia. Therefore, their contribution to Indonesia's economic development is expected to continue to increase.

According to data from the Direktorat Jenderal Perkebunan (2024), North Sumatra Province is expected to have the third-largest area of oil palm plantations and the fifth-largest area of smallholder oil palm plantations in Indonesia. Smallholder oil palm plantations in North Sumatra Province are spread across 22 regencies/cities, covering the East Coast, West Coast, Highlands, and Nias Islands. By 2023, the area of smallholder oil palm plantations in North Sumatra Province is expected to reach 488,414 hectares, primarily located on the east coast.

To date, the performance of smallholder oil palm plantations, measured by productivity, remains below that of large privately owned and state-owned plantations. The primary problem with smallholder oil palm plantations is low crop productivity due to inadequate management practices. The productivity gap between smallholder oil palm plantations and large plantations remains relatively large, ranging from 41% to 64%, or 7-20 tons of fresh fruit bunches (FFB) per hectare per year (Suharno et al., 2015).

Therefore, to increase palm oil production in Indonesia, efforts to improve the productivity and efficiency of smallholder oil palm plantations are crucial. The significant contribution of smallholder oil palm plantations to national oil palm production means that increased efficiency in smallholder plantations will have a substantial impact on national plantation production efficiency (Setiyanto, 2015).

Increasing farm production requires appropriate management practices. Farm management refers to the ability of farmers to optimally coordinate the use of their available production factors to achieve their desired production outcomes. Farm production factors consist of four components: land, capital, labor, and skills (management). These factors serve as inputs into the farm production process. The farm production process combines these input factors to produce agricultural output (Arifin, 2015).

According to Nguyen et al., (2018), measuring and assessing farm production efficiency is a method for determining the level of input use (input combination) used by farmers to maximise output and determining potential efforts to improve this efficiency. This study aims to analyse the level of economic efficiency of smallholder oil palm plantations and the socio-economic factors influencing this efficiency in Lubuk Barumun District, Padang Lawas Regency, North Sumatra Province.

Literature Review

In general, farmers carry out farming activities based only on habits and estimates. Therefore, rationality is needed to obtain maximum results and profits. Farmers have the opinion that the more inputs they use, the more results they will get. Imbalances in the use of production inputs often result in less than optimal income for farmers (Wulandari et.al, 2019).

The fundamental concept of efficiency is divided into technical efficiency and economic efficiency. Technical efficiency focuses on input relative to output; that is, minimising inputs

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results in the same quantity of output. Economic efficiency is a broader concept than technical efficiency, whereby economic efficiency requires selecting the right mix of inputs and outputs to optimise economic performance by minimising costs and maximising profits (Aziza et.all., 2022)

Economic efficiency occurs when farmers increase their yields by reducing the price of production factors and selling their output at a high price. In other words, farmers are simultaneously achieving economic efficiency, as well as technical and price efficiency. The concept of economic efficiency is cost minimisation, meaning a production process will be economically efficient at a given output level if no other process can produce the same output at a lower cost (Chotimah, 2019).

The persistently low productivity of smallholder oil palm plantations in North Sumatra Province and even in Indonesia indicates that production efficiency (including economic efficiency) in oil palm plantations is also low. Thus, the study of the economic efficiency of smallholder oil palm plantations aims to optimise resource utilisation and minimise wasteful use, thereby facilitating better management of smallholder oil palm plantations in the future.

Various factors, including socioeconomic factors, influence the economic efficiency of oil palm plantations. Research on socioeconomic factors cannot be traced to the economic efficiency of oil palm plantations. What is found is the economic efficiency of non-smallholder oil palm farms, as well as the socioeconomic factors that influence it. Study of effect famer gender on economic efficiency has been conducted by Asfaw (2019), Effendy et al., (2019) and Obi and Ayodeji (2020). Study of effect famer age on economic efficiency has been conducted byt Asfaw (2019), Rosdiantini (2020), Iskandar (2022), Imran et al., (2019), and Chebil et al., (2015). Study of farmer education on economic efficiency has been conducted by Rosdiantini (2020), Chebil et al., (2015), Haile (2015), Teferra et al., (2018) and Asfaw (2019). Study of effect farmer farming experience on economic efficiency has been conducted by Iskandar (2022), Obi and Ayodeji (2020), Haile (2015), (Rosdiantini, 2020) and (Chebil et al., 2015). Study of effect farmer family size on economic efficiency has been conducted by Iskandar (2022), Rosdiantini (2020) and Haile (2015). Study of effect type of seed used by farmer on economic efficiency has been conducted by Effendy et al., (2019). Study of effect number of productive crops cultivated by farmer on economic efficiency has been conducted by Chebil et al., (2015). Study of effect farmer credit access on economic efficiency has been conducted by Teferra et al., (2018), Haile (2015), Obi and Ayodeji (2020), Effendy et al., (2019) and Imran et al., (2019). Study of effect distance from farmer's residence to input market on economic efficiency has been conducted by Teferra et al., (2018). Stydy of effect farmer experience applying organic fertilizer on economic efficiency has been conducted by Effendy et al., (2019). Study of effect farmer experience in participating in farmer organisations on economic efficiency has been conducted by Effendy et al., (2019). Study of effect farmer experience in using information and technology tools related to farm management on economic efficiency never been done or can non be traced.

The study will utilize the twelve variables above as factors effecting on economic efficiency of smallholder oil palm plantations. In addition, studies that has been conducted generally uses the Stochastic Frontier Method while this study use Data Envelopment Analysis Method as something new approach in study of smallholder oil palm plantations,

Research Method

The research area was determined purposively (intentionally) with consideration because according to data from the BPS Provinsi Sumatera Utara (2024), and the BPS Kabupaten Padang Lawas (2024), Barumun District is the area that has the largest area of oil palm plantations in Padang Lawas Regency, while Padang Lawas Regency is the regency that has the largest area of

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oil palm plantations in the West Coast region of North Sumatra Province. The research sample was determined through quota sampling of 150 oil palm plantation farmers from two villages in Padang Lawas District: Aek Lancat Village, with 75 samples, and Pagaran Mompang Village, with 75 samples. The research data are in the form of primary data obtained directly from farmers through interviews using a prepared questionnaire, providing information on the management of smallholder oil palm plantations for the year 2023.

Economic Efficiency Calculation

Economic efficiency calculations were performed using the Data Envelopment Analysis (DEA) method. This non-parametric approach utilises a deterministic (linear programming) approach to analyse production functions by mapping the production frontier (Camanho et. al., 2024) This study employed input-oriented DEA because it aimed to determine the optimal combination of inputs that yields the maximum output. The model used was the VRS (variable returns to scale) model, also known as pure efficiency. The VRS model is used to estimate efficiency when increases or decreases in inputs or outputs do not result in proportional changes in output. This model assumes that the company is not yet operating at its optimal scale. The VRS model can exhibit increasing, constant, and decreasing returns to scale (Rusydiana, 2013), as noted in Sulistyaningsih et al., (2019).

Economic efficiency is calculated using a cost-efficiency model, where the cost minimisation or economic efficiency (EE) of the i-th input vector for a DMU is given by X_i, the input price vector is W_i', and its output level is Y_i. Overall, the EE score of the i-th DMU is calculated as the ratio of the minimum cost, where the cost is observed and is proportional to the EE score. If EE = 1 is considered economically efficient, EE < 1 indicates that EE is not achieved (Camanho et. al., 2024).

Thus, Economic Efficiency (EE) can be calculated using the following equation:

$$EE = \frac{W_i' X_i'}{W_i' X_i}$$

Where:

EE = Economic Efficiency based on the principle of cost minimization $(0 \leq EE \leq 1)$
X_i = Actual Input Quantity (Land, Labor, Fertilizer, Pesticide)
W_i' = Input Price (Land, Labor, Fertilizer, Pesticide)
X_i' = Target Input Quantity

DEA analysis results also provide information on the amount of input costs that farmers should use to achieve an economically efficient production process. Therefore, smallholder oil palm farmers must adjust their input costs (either reduce or increase) for the future. The percentage change in input costs can be determined using the following formula:

$$\text{Percentage change in input costs (\%)} = \frac{\text{Actual Input Cost} - \text{Target Input Cost}}{\text{Actual Input Cost}} \text{ x } 100\ \%$$

Note:
Actual input cost is the cost of using inputs obtained from respondent farmers.
Target input cost refers to the cost of utilising inputs recommended by the DEA model.

The Effect of Farmer Socioeconomic Factors on Economic Efficiency

To analyse the effect of farmer socioeconomic factors on economic efficiency, a Censored Tobit Regression Test can be performed. The Censored Tobit method is based on the assumption that all independent variables have uncensored or unrestricted values, but the dependent variable is censored. All variables (independent and dependent) can be measured accurately, and the mathematical model used is accurate, with no autocorrelation, heteroscedasticity, or perfect multicollinearity (Lin et al., 2022).

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The Tobit Regression function in this study can be written as described by Amore & Martinu (2021) :

$$EF = b_0 + b_1X_1 + b_2X_2 + \ldots + \ldots\ldots\ldots\ldots + b_{12}X_{12} + e$$

Description:

EF = Economic efficiency score obtained from DEA
b_0 = Intercept
b_1-b_{12} = Regression Coefficient
X_1 = Farmer Gender (0 = Female; 1 = Male)
X_2 = Farmer Age (years)
X_3 = Farmer Education (years)
X_4 = Farmer Farming Experience (years)
X_5 = Farmer Family Size (persons)
X_6 = Type of Seed Used by Farmer (0 = Uncertified; 1 = Certified)
X_7 = Number of Productive Crops Cultivated by Farmer (trees)
X_8 = Farmer Credit Access (0 = None; 1 = Yes)
X_9 = Distance from Farmer's Residence to Input Market (km)
X_{10} = Farmer Experience Applying Organic Fertilizer (years)
X_{11} = Farmer Experience in Participating in Farmer Organisations (years)
X_{12} = Farmer Experience in Using Information and Technology Tools Related to Farm Management (years)

The partial effect of the independent variable (X_i) on the dependent variable (Y) can be determined by conducting the Z-test. The test criteria used are:

1. If the probability value Z is ≥ 0.05, then the independent variable Xi has no significant partial effect on Y.
2. If the probability value Z is < 0.05, then the independent variable Xi has a significant partial effect on Y.

The simultaneous effect of independent variables (X_i) on the dependent variable (Y) can be determined by conducting a Likelihood Ratio Test or G-Test using the following test criteria according to Upaya (2021):

1. If the likelihood ratio probability value is ≥ 0.05, then all independent variables simultaneously have no significant effect on Y.
2. If the likelihood ratio probability value is <0.05, then all independent variables simultaneously have a significant effect on Y.

The magnitude of the effect of X_1, X_2, and X_{12} on Y can be determined from the coefficient of determination (R^2). The value of $1 - R^2$ represents the magnitude of the influence of other independent variables not included in the model or not studied.

Results and Discussion

1. Descriptive Statistics

The descriptive analysis of the research data encompasses both the descriptive analysis of input-output cost variables and the descriptive analysis of farmer socio-economic factors.

a. Descriptive Analysis of Input-Output Cost Variables

The input-output cost variables in this study include land area, labour, fertilizer, pesticides, and smallholder oil palm plantation production in the study area for 2023, as shown below.

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Table 1. Descriptive Statistics of Input-Output Cost Variables

No.	Variable Input-Output Cost	Mean	Min	Max	Std. Dev.
1	Land Cost (Rp)	5.769.333,33	1.300.000,00	15.500.000,00	3.075.993,79
2	Labor Cost (Rp)	7.868.000,00	1.600.000,00	19.200.000,00	3.760.467,63
3	Fertilizer Cost (Rp)	3.220.700,00	550.000,00	11.850.000,00	1.944.725,62
4	Pesticide Cost (Rp)	873.233,33	212.500,00	2.380.000,00	460.654,41
5	Production (kg FFB)	55.096,67	12.300,00	148.800,00	28.765,76

Source: Primary Data Processing

b. Descriptive Analysis of Socioeconomic Factor Variables

The socioeconomic factor variables in this study consist of farmer gender, farmer age, farmer education, farmer farming experience, farmer family size, type of seed used, number of productive crops cultivated, farmer access to credit, distance from farmer residence to input markets, farmer experience applying organic fertilizer, farmer participation in farmer organizations, and farmer experience in using information and technology tools related to farm management, as shown below.

Table 2. Descriptive Statistics of Socioeconomic Factor Variables

No.	Factor Variable Socioeconomic	Mean	Min	Max	Std. Dev.
1	Gender (0 = female ; 1 = male)	0,5733	0	1	0,4962
2	Age (Years)	51,7200	42	62	4,3507
3	Education (Years)	12,5867	9	17	2,0140
4	Farming Experience (Years)	19,1600	14	24	2,4054
5	Family Size (People)	5,5267	4	7	0,8085
6	Seed Type (0 = random ; 1 = certified)	0,6133	0	1	0,4886
7	Number of Plants (Trees)	274,5400	65	706	143,4659
8	Access to Credit (0 = None ; 1 = Yes)	0,3667	0	1	0,4835
9	Distance to Input Market (Km)	2,1753	1,4	3,5	0,4625
10	Organic Fertilizer Application (Years)	3,0200	0	10	4,2843
11	Organisational Experience (Years)	12,8467	8	16	1,7677
12	IT Experience (Years)	2,3077	5	8	0,9722

Source: Primary Data Processing

2. Economic Efficiency Calculation

The results of the economic efficiency calculation for smallholder oil palm plantations are presented in Table 3.

Table 3. Economic Efficiency of Smallholder Oil Palm Plantations

No.	Description	Mean	Min	Max	Std. Dev.
1	Economic Efficiency	0,8789	0,7410	1	0,0657

Source: Primary Data Processing

Based on Table 3, the average economic efficiency value for smallholder oil palm plantations is 0.8789, with a minimum value of 0.7410, a maximum of 1, and a standard deviation of 0.0657.

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Based on this average economic efficiency value, it can be concluded that the respondent farmers' ability to minimise input usage and input costs to obtain economically efficient outputs is 87.89%. Farmers still have the opportunity to achieve higher potential yields, reaching the maximum yields achieved by the most economically efficient farmers. The results of this study indicate that farmers, overall, can still increase their economic efficiency by 12.11% at the existing level of technology and inputs.

Based on the economic efficiency values obtained, the research samples can be categorised as efficient and inefficient, as shown in Table 4.

Table 4. Share of Economic Efficiency Values

No.	Economic Efficiency Value	Number (Sample)	Percentage (%)
1	Efficient (EE Value = 1)	5	3,33
2	Inefficient (EE Value < 1)	145	96,67
	Total	150	100,00

Source: Primary Data Processing

Table 4 shows that the majority (96.67%) of sample farmers have economically inefficient production processes (EE Value < 1), and 3.33% of sample farmers have economically efficient production processes (EE Value = 1).

Further DEA analysis of production scale (rate of technical substitution or RTS) based on economic efficiency reveals that smallholder oil palm plantation production processes exist at various production scales, as shown in Table 5.

Table 5. Share of Production Scale Based on Economic Efficiency Analysis

No.	Production Scale	Number (Sample)	Percentage (%)
1	Increasing Returns to Scale (IRS)	22	14,67
2	Constant Returns to Scale (CRS)	0	0,00
3	Decreasing Returns to Scale (DRS)	128	85,33
	Total	**150**	**100,00**

Source: Primary Data Processing

Table 5 shows that of the 150 research samples, the majority, or 85.33%, exhibit decreasing returns to scale, and 14.67% exhibit increasing returns to scale.

Based on the economic efficiency values of smallholder oil palm plantations, which are largely inefficient, the DEA analysis provides further insights into the use of actual input costs and target input costs, as well as changes in input use required to achieve economic efficiency. This description is presented in Table 6.

Table 6. Summary of Actual Input Costs, Target Input Costs, and Changes in Input Cost Use Based on Economic Efficiency Values

No.	Description	Mean	Min	Max	Std. Dev.
	Actual Input Cost				
1	Land (Rp)	5.769.333,33	1.300.000,00	15.500.000,00	3.075.993,79
2	Labor (Rp)	7.868.000,00	1.600.000,00	19.200.000,00	3.760.467,63
3	Fertilizer (Rp)	3.220.700,00	550.000,00	11.850;000,00	1.944.725,62
4	Pesticides (Rp)	873.233,33	212.500,00	2.380.000,00	460.654,41
	Target Input Cost				

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1	Land (Rp)	5.910.587,18	1.300.000,00	15.500.000,00	3.072.980,83
2	Labor (Rp)	6.536.798,36	1.600.000	19.200.000,00	3.517.984,62
3	Fertilizer (Rp)	2.344.606,74	285.121,44	11.850.000,00	1.621.871,35
4	Pesticides (Rp)	892.279,87	212.500,00	2.380.000,00	461.621,31
	Change in Input Cost				
1	Land (%)	-3,0507	-9,8645	4,2667	2,2372
2	Labor (%)	18,2582	-4,7075	34,8250	9,0144
3	Fertilizer (%)	22,6218	-16,3855	69,0126	32,1284
4	Pesticides (%)	-2,9480	-26,5060	46,4286	5,7258

Source: Primary Data Processing

3. The Effect of Farmer Socioeconomic Factors on Economic Efficiency

Farmer socioeconomic factors suspected of effecting economic efficiency and serving as independent variables in this study include farmer gender (X_1), farmer age (X_2), farmer education (X_3), farming experience (X_4), farmer family size (X_5), type of seed used (X_6), number of productive crops cultivated (X_7), farmer access to credit (X_8), distance from farmer's residence to input markets (X_9), farmer experience applying organic fertilizer (X_{10}), farmer participation in farmer organizations (X_{11}), and farmer experience in using information and technology tools related to farm management (X_{12}). The effect of the independent variables on the dependent variable can be determined through a Censored Tobit Regression Test, the results of which are shown in Table 7.

Table 7. Censored Tobit Regression Test Results

No.	Variable	Coefficient	Probabilty Z	Std. Error
1	Gender	0,0273	0,001*	0,0085
2	Age	-0,0000	0,977	0,0008
3	Education	0,0011	0,503	0,0016
4	Farming Experience	0,0052	0,008*	0,0020
5	Family Size	-0,0096	0,035*	0,0046
6	Type of Seed Used	0,0207	0,009*	0,0080
7	Number of Productive Plants	-0,0000	0,546	0,0000
8	Access to Credit	0,0050	0,492	0,0072
9	Distance from Residence to Input Market	0,0389	0,001*	0,0114
10	Experience in Farming Organic Fertilizer	-0,0075	0,000*	0,0008
11	Organisational Participation Experience	0,0034	0,215	0,0027
12	IT Facilities Experience	0,0038	0,510	0,0058
	Likelihood	157,61	0,000*	
	Coefficient of Determination (R^2)	0,6608		

Source: Primary Data Processing
Note: Significant at $\alpha = 0.05$

a. The Partial Influence of Socioeconomic Factors on Economic Efficiency

Based on the results of the Censored Tobit Regression Test in Table 7, the partial effect of farmer socioeconomic factors on the economic efficiency of smallholder oil palm plantations can be explained as follows:

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1) Farmer gender partially has a significant positive effect on the economic efficiency of smallholder oil palm plantations. The economic efficiency of smallholder oil palm plantations shows significant differences based on farmer gender, with male farmers having more economically efficient farming production processes than female farmers. These research results align with the findings of Asfaw (2019) and Effendy et al., (2019), but are inconsistent with those of Obi and Ayodeji (2020).

2) Farmer age has no significant effect on the economic efficiency of smallholder oil palm plantations. The economic efficiency of smallholder oil palm plantations does not show significant differences based on the age of the farmers. The research results obtained are in line with those of Iskandar (2022), Imran et al., (2019), and Chebil et al., (2015); however, they do not align with the findings of Asfaw (2019) and Rosdiantini (2020).

3) Farmer education had no significant effect on the economic efficiency of smallholder oil palm plantations. The economic efficiency of smallholder oil palm plantations showed no significant differences based on the level of farmer education. The results of this study align with those of Rosdiantini (2020), Chebil et al., (2015), and Haile (2015) but differ from those of Teferra et al., (2018) and Asfaw (2019).

4) Farmer farming experience partially had a significant positive effect on the economic efficiency of smallholder oil palm plantations. The economic efficiency of smallholder oil palm plantations showed significant differences based on their farming experience, with farmers who had more experience in farming exhibiting more economically efficient farming production processes than those with less experience. These results align with those of Iskandar (2022), Obi and Ayodeji (2020), and Haile (2015), but not with those of (Rosdiantini, 2020) and (Chebil et al., 2015)

5) The farmer family size partially has a significant adverse effect on the economic efficiency of smallholder oil palm plantations. The economic efficiency of smallholder oil palm plantations shows significant differences based on family size, with farmers with smaller families experiencing more economically efficient farming production processes than those with larger families. The results of this study align with those of Iskandar (2022) but differ from those of Rosdiantini (2020) and Haile (2015).

6) The type of seed used by farmers partially has a significant positive effect on the economic efficiency of smallholder oil palm plantations. The economic efficiency of smallholder oil palm plantations shows significant differences based on the type of seed used, with farmers using certified seeds experiencing more economically efficient farming production processes than those using uncertified seeds. These results align with those of Effendy et al., (2019).

7) The number of productive crops cultivated by farmers had no significant effect on the economic efficiency of smallholder oil palm plantations. The economic efficiency of smallholder oil palm plantations showed no significant difference based on the number of productive crops cultivated by farmers. The results of this study are inconsistent with those of Chebil et al., (2015).

8) Farmers' access to credit had no significant effect on the economic efficiency of smallholder oil palm plantations. The economic efficiency of smallholder oil palm plantations showed no significant difference based on their access to credit. The results of this study align with those of Teferra et al., (2018), Haile (2015), and Obi and Ayodeji (2020), but do not align with those of Effendy et al., (2019) and Imran et al., (2019).

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9) The distance from farmers' residences to input markets partially had a significant positive effect on the economic efficiency of smallholder oil palm plantations. The economic efficiency of smallholder oil palm plantations exhibits significant differences based on the distance from the farmer's residence to the input market. Specifically, farmers whose residences are further from the input market tend to have more economically efficient farming production processes than those whose residences are closer to the input market. The research results obtained do not align with those of Teferra et al., (2018)..

10) Farmers' experience in applying organic fertiliser partially had a significant adverse effect on the economic efficiency of smallholder oil palm plantations. The economic efficiency of smallholder oil palm plantations showed a significant difference based on their experience in applying organic fertiliser, where farmers with less experience in applying organic fertiliser were more economically efficient in their farming production processes than those with more experience. The results of this study are inconsistent with those of Effendy et al., (2019).

11) Farmers' experience in farmer organisations had no significant effect on the economic efficiency of smallholder oil palm plantations. The economic efficiency of smallholder oil palm plantations did not show any significant difference based on their experience in participating in farmer organisations. The results of this study are inconsistent with those of Iskandar (2022).

12) Farmers' experience in using information and technology tools related to farm management had no significant effect on the economic efficiency of smallholder oil palm plantations. The economic efficiency of smallholder oil palm plantations did not show any significant difference based on their experience in using information and technology tools related to farm management.

b. The Simultaneous Effect of Farmers' Socioeconomic Factors on Economic Efficiency

Farmers' socioeconomic factors simultaneously have a significant effect on the economic efficiency of smallholder oil palm plantations. That is demonstrated by the coefficient of determination (R^2) of 0.6608, indicating that the independent variables contribute 66.08% to the economic efficiency of smallholder oil palm plantations, while other factors not included in the regression model or not studied contribute 33.92%.

Conclusion

Most (85.33%) of smallholder oil palm plantations in Lubuk Barumun District, Padang Lawas Regency, are not economically efficient, with an average economic efficiency value of 0.8789. Efforts to achieve a technically efficient production process require smallholder farmers to make changes in the use of input costs, namely increasing land costs by 3.0507%, reducing labour costs by 18.2582%, reducing fertiliser costs by 22.6218%, and increasing pesticide costs by 2.9480%. Gender, farming experience, family size, type of seed used, distance from the farmer's residence to the input market, and experience in applying organic fertiliser have a significant effect on the economic efficiency of smallholder oil palm plantations. Meanwhile, age, education, the number of productive oil palm plants cultivated, access to credit, experience of participation in farmer organisations, and experience of farmers using information and technology facilities related to farming management have no significant effect on the economic efficiency of smallholder oil palm plantations.

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