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The Comparison of replanting techniques on smallholder palm oil in Muaro Jambi

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Abstract

Full replanting and underplanting techniques in oil palm cultivation by farmers in the Muaro Jambi region and the results of fresh fruit bunches of oil palm farmers vary. This is due to the number of oil palm plants and the age of the oil palm plants which affect the total oil palm production and farmer income. This study aims to: (1) produce oil palm farming income for farmers based on replanting techniques; and (2) analyze the calculation of oil palm farming income for farmers based on replanting techniques. The data used were obtained through interviews using questionnaires. The study was conducted in the Muaro Jambi region in 2024, using simple random sampling of independent farmers who replanted oil palm. The research sample consisted of 120 farmers, including 60 oil palm farmers who applied the full replanting technique and 60 farmers who applied the underplanting technique. The research data were analyzed using descriptive statistics and t-tests. The results of the study showed that there were differences in the number of plants in the two replanting techniques which affected production and income. The income of smallholder oil palm farmers who used the full replanting technique was better than the underplanting technique. The results of the study also showed that the income of smallholder oil palm farmers through the full replanting technique was significantly different from the significant income from the underplanting technique.

Keywords: Palm oil; Smallholder; Full replanting technique; Underplanting technique

1 Introduction

The area of oil palm plantations in Jambi Province varies from year to year, increasing from 714,399 hectares in 2019 to 927,677 hectares in 2023, with an average annual increase in land area of 4.60%. Production increased from 1,794,875 tons in 2018 to 2,162,544 tons in 2022, with an average annual increase in production of 3.40%. The land, area, and production of smallholder oil palm that have been maximized will continue to increase in the coming years [1]. Muaro Jambi Regency is one of the areas in Jambi Province where oil palm plantations are growing rapidly. The area of oil palm in 2019–2023 in Jambi Province can be seen in Table 1 below.

Table 1 Palm oil plantation acreage and production in Jambi Province year of 2019-2023

	Acreage	(ha)		Production (tonne)		
Year	PR	PN	PS	PR	PN	PS
2019	450,075	23,758	240,566	998,243	84,713	711,919
2020	457,321	23,991	254,783	1,013,114	90,699	806,216
2021	463,952	24,276	267,293	1,044,724	95,242	938,497

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2022	586,940	21,678	289,857	1,375,617	88,239	884,365
2023	630,332	23,873	273,472	1,183,545	87,572	891,427
Total	3,421,445	170,676	1,786,785	7,606,542	616,817	5,667,650

Source: Board of Plantation Estate Jambi Province, year of 2024[a]

Muaro Jambi is an area with the largest oil palm plantation area in Jambi Province, which is 136,405.25 hectares, with a total production of 232,725.23 tons in 2023. Smallholder oil palm plantations in the district have been operating since the 1980s. Therefore, most of the oil palm trees owned by the community have now entered the final stage of the production cycle, so rejuvenation activities need to be planned [2].

Table 1 shows that the area of smallholder oil palm plantations (PR) is much larger than the other two plantations. However, the problem that arises is that the productivity of smallholder oil palm plantations is less competitive than state-owned plantations (PN) and private plantations (PS). This condition occurs due to various factors, both internal and external to the management actors, in this case farmers or planters. To find out the area of smallholder oil palm plantations in Jambi Province, see Table 2 below.

Table 2 Land acreage of smallholders palm oil in Jambi province year of 2023

	Land	**Acreage (ha)**		**Total (ha)**	**Production (tonne)**
District	**TBM**	**TM**	**TTM/TT**		
Batanghari	30,629	69,098	1,928	110,655	140,905
Muaro Jambi	15,908	89,964	30,533	136,405	232,725
Bungo	31,639	36,715	1,418	69,772	112,792
Tebo	14,263	55,339	1,419	68,183	121,532
Merangin	11,443	53,199	4,180	68,822	138,631
Sarolangun	19,253	25,336	8,983	53,572	99,750
Tanjab Barat	19,162	63,222	2,602	84,986	124,460
Tanjab Timur	13,072	23,450	1,331	37,853	76,378
Kerinci	60	19	5	84	14
Total	108,046	376,374	22,042	506,462	1,047,187

Source: Estate Board of Jambi Province, the year of 2024[a]

Table 2 shows that the Muaro Jambi region has the largest acreage of unproductive palm oil (TTM/TM) compared to other regions and is listed as the largest old mill. This fact shows that the Muaro Jambi region has the largest area of non-productive smallholder palm oil plantations compared to other regions. One of the sub-districts in Muaro Jambi District, Sungai Bahar Sub-District, was a palm oil plantation area under the PIR programme of PT. Perkebunan Nusantara VI. In this area, based on the data in Table 3 below.

Table 3 Land Acreage of Smallholders Palm Oil based on Sub-district in Muaro Jambi District, Year of 2023

Land Acreage (ha)				**Total**	**Production (ton)**
District	**TBM**	**TM**	**TTM/TT**	**(ha)**	
Jaluko	683	4,363	5,660	4,916	16,360
Sekernan	3,572	21,798	2,146	17,656	37,604
Kumpeh Ilir	1,167	13,501	372	12,399	24,679
Muaro Sebo	3,509	6,301	0	9,803	15,235
Kumpeh Ulu	1,777	14,075	0	14,916	39,737

Sungai Bahar	1,858	14,670	9,732	22,746	33,689
Bahar Selatan	666	2,382	5,537	5,579	6,525
Bahar Utara	299	2,361	5,354	4,004	6,225
Sungai gelam	1,253	6,579	1,732	1,124	1,950
Total	15,908	89,964	30,533	136,405	232,725

Source: Estate Board of Jambi Province, the year of 2024[a]

According to the data in Table 3, the area of unproductive or old factories in the Sungai Bahar subdivision accounts for 60.83% of the total land area of the subdivision. This condition is not only due to limitations in the cultivation of palm oil plantations by farmers but also causes a bad situation in the age of unproductive palm oil plants (aged 25 years and over) with productivity below 10 tons/ha/year [2]. In 2021, there is a replanting plan in the Sungai Bahar sub-district. This fact shows that from 2021 to 2022, there was an increase in the area for immature plants and a reduction in the area for non-productive or old plants [1]. The land acreage of the target and realisation of smallholder palm oil in Muaro Jambi District can be seen in the following table.

Table 4 Target and realization of replanting land acreage of smallholders palm oil in Jambi Province year of 2021–2022

		The year	**of 2021**		**The year of 2022**		
No	**District**	**Target**	**Realization**	**%**	**Target**	**Realization**	**%**
1	Merangin	685	555.18	81.05	4,000,00	0	0
2	Bungo	1,000	160.96	16.10	1,259.95	60.64	4.81
3	Muaro Jambi	1,000	293.11	29.31	3,500.00	197.75	5.65
4	Tanjab Barat	800	171.18	21.41	3,210.00	751.92	23.42
5	Batanghari	760	0	0	2,027.32	119.94	5.92
6	Tebo	0	0	0	1,740.00	0	0
7	Sarolangun	0	0	0	0	0	0
	Total	4,245	1,180.00		15,737.00	1,130.00	

Source: Estate Board of Jambi Province, the year of 2023[a]

Table 4 shows that the achievement of rejuvenation activities has not reached the target and tends to decline. Muaro Jambi Regency is the regency with the highest rejuvenation target but has reached 29.31% since 2021, while the 2022 target of 5.65 hectares has not been achieved. This condition is of course inseparable from the influence of farmers' decisions as the main actors in oil palm farming. The choice of oil palm rejuvenation techniques in the Muaro Jambi area will affect the amount of production costs incurred by farmers for oil palm farming. Lower production costs have a significant impact on the income of smallholder oil palm. From the description above, the objectives of the study are (1) to analyze the income of smallholder oil palm farming from each rejuvenation technique in Muaro Jambi Regency and (2) to analyze the comparison of income of smallholder oil palm farming from each rejuvenation technique in Muaro Jambi Regency.

2 Methods

Considering that Muaro Jambi Regency is one of the largest oil palm plantation areas in Jambi Province, the research location was deliberately in Muaro Jambi Regency, Jambi Province. The research sample was determined using the cluster random sampling method. Considering the attention of samples that have different oil palm plantation replanting patterns, the number of samples was 120 households (60 samples of full replanting patterns of smallholder oil palm farmers and 60 samples of underplanting patterns of smallholder oil palm farmers). This research was conducted in 2024. An empirical approach was carried out towards the two objectives that had been stated at the beginning of the study. First, an analysis of the performance assessment of the smallholder oil palm replanting technique was carried out. Second, a comparative analysis of the full replanting technique and the underplanting technique on smallholder oil palm plantations was carried out.

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2.1 Farming income

Smallholder palm oil farming income can be calculated using the formula as follows:

$$P_d = TR – TC$$

where: P_d is income (IDR), TR is total revenue (IDR) and TC is total cost (IDR). [3].

2.2 Significant Testing (t-test)

A significance test (t-test) is used to see the significance of the effect of an independent variable on a dependent variable while holding other variables constant. To test whether there is a difference in the benefits of palm oil planting between full replanting technology and underplanting experiments, the statistical hypothesis formula H_0 is used: $\mu_1=\mu_2$, H_1: $\mu_1>\mu_2$.

The research hypothesis is tested using a significance test of two separated variance-independent samples [4] as follows:

$$T_{count} = \frac{X1 - X2}{\frac{\sqrt{S1^2 + S2^2}}{n1\ n2}}$$

where, n_1 is the number of respondents of oil palm farmers using the full replanting technique; n_2 is the number of respondents of oil palm farmers using the underplanting technique; X_1 is the average income of oil palm farmers using the full replanting technique; X_2 is the average income of oil palm farmers using the underplanting technique; S_1^2 is the variance of the average income of oil palm farmers using the full replanting technique and S_2^2 is the variance of the average income of oil palm farmers using the underplanting technique.

The test evaluation was done by comparing the t_{count} value with the t_{table} value as follows:

- If $t_{count}>t_{table}$, then H_0 is rejected, and H_1 is accepted, which means that the full replanting technique provides higher income compared to the underplanting technique.
- If $t_{count}\leq t_{table}$, then H_0 cannot be rejected, H_1 is not accepted, which means that the full replanting techniques do not provide a higher income compared to the underplanting techniques.

3 Results and Discussion

Rejuvenation is an effort to develop plantations by replacing old or unproductive plants with young plants, either completely or gradually, including managing plantation risks such as those caused by spatial planning, forest areas, and peat hydrology units [5-6]. The Decree of the Director General of Plantations also states that rejuvenation activities are carried out on former PIR plantations and also on independent plantations that have not used certified superior seeds (illegal). Conventional or simultaneous rejuvenation techniques are carried out by removing old plants in their entirety, followed by soil cultivation and planting young plants [7]. This technique can also be followed up by planting intercropping plants, such as legumes, which help the soil obtain additional nitrogen. This technique has the advantage of being a more ideal planting medium for plants because the soil is cultivated more intensively, so that in the long term it will have a good impact on the environment of oil palm plants. However, this technique has the disadvantage of cutting off farmers' income from the sale of Fresh Fruit Bunches (FFB) and plant maintenance costs for approximately 3 years [8-9].

According to [10], oil palm rejuvenation can be done if the age of the plant has exceeded the economic age of around 25 years with productivity below 12 tons of FFB/ha/year which results in decreased farmer income, difficulty in harvesting due to tall plants and difficulty in harvesting, harvest effectiveness and low plant density. Areas with low plant density are not economical to manage so rejuvenation is necessary. The problem of low production and low quality is compounded by another problem, namely the price received by farmers does not have a high bargaining position against the palm oil factory, therefore an investment assessment is needed to provide verification related to the financial feasibility of rejuvenation with full replanting techniques and underplanting techniques [11-12].

The full replanting technique or simultaneous uprooting is done by uprooting the old plants as a whole, followed by soil cultivation and planting young plants. This technique can also be followed up by planting intercrops, such as legumes, which help the soil get additional nitrogen. The advantage of this technique is that it becomes a more ideal plant growing medium, because soil cultivation is more concentrated, so that in the long term it will have a good effect on the environment of oil palm plants [13]. However, this technique has a weakness, namely the interruption of farmer income from the sale of Fresh Fruit Bunches (FFB) and plant maintenance costs for approximately 3 years [14]. Meanwhile, the underplanting technique is a replanting technique that is done by planting young plants between old plants. The recommended method is to uproot as much as 50% of the old plant population, with the aim of not inhibiting growth due to competition for nutrients and sunlight. Then for the remaining 50% of the old plants, 25% are uprooted per year. The advantage of this technique is that farmers still have the opportunity to earn income as long as the plants that are replanted come from old plants that have not been uprooted or poisoned. The disadvantages of this technique are technical problems, such as the growth of young plants being inhibited by the remains of old plants being poisoned and competition in obtaining nutrients and sunlight. This condition certainly causes long-term losses because the plants cannot grow well [15-16].

3.1 Production

Rejuvenation of oil palm plants using full replanting and underplanting techniques produces a lifespan of 8 years and is predicted to last for 25 years. Rejuvenation of oil palm plants using full replanting and underplanting techniques produces a lifespan of 8 years and is predicted to last for 25 years. The full replanting technique in the first and second years was not accepted because the oil palm plants had not yet produced, then in the 3rd year the full replanting technique began to produce, thus producing the first income of IDR. 6.64 million until the 25th year it obtained an income of IDR. 696.64 million [17]. The underplanting technique in the first year has been accepted because in the underplanting technique there are still old plants that are still producing. Thus, it can obtain an income of IDR. 11.27 million until the 25th year of IDR. 315.19 million. It can be seen that young plants using the full replanting technique from the first year to the fourth year on average have not received any income because young plants using the underplanting technique have not yet produced, so they can only produce for the first time in the 4th year at a price of IDR.

3.2 Cost, Revenue, and Income of Palm Oil Plantations

Most of the large oil palm farmers in the research area are smallholder farmers with an area of oil palm plantations around the radius of the total area of oil palm plantations in 2021. This condition occurs in most of the research areas, and some use full replanting and underplanting techniques. Then, the results of the study show that from an economic perspective, oil palm plantations have become a strategic commodity. Economically, it has contributed to the GRDP of Muaro Jambi Regency and financially has made a significant contribution to the standard of living of farmers. The income of oil palm farmers is the difference between total income and total costs. The income obtained by oil palm farmers is the result of oil palm production multiplied by the price, then reduced by the costs incurred during the production process. As seen in Table 5 below, the amount of income obtained by respondents from smallholder oil palm plantations with full replanting and underplanting techniques.

Table 5 shows that the average income of farmers who apply the full replanting technique is IDR. 47,365,179/farmer/year and income of IDR. 26,650,289/farmer/year. While the average income of farmers who apply the lower planting technique is IDR. 34,819,273/hectare and income of IDR. 20,667,343/farmer/year. The amount of income obtained by farmers is greatly influenced by the amount of production costs incurred.

Table 5 Analysis of palm oil farming income in full replanting technique and underplanting technique it research areas

Description	Full Replanting Technique		Underplanting Technique	
	IDR/farmer	IDR/ha	IDR/farmer	IDR/ha
A. Revenue				
1. Production (kg)	34,520	18,168	30,920	16.274
2. Price (IDR)	1,621	1,621	1,707	1,707
Total Revenue (IDR)	55,956,920	39,452,000	52,780,440	27,779,718
B. Cost (IDR)				
1. Fertilize	5,128,143	8,108,947	10,966,167	4,285,263
2. Pesticide	598,333	1,014,912	980,000	329,825
3. TKLK	1,219,000	1,941,579	3,750,000	1,392,807
4. Other Cost	1,250,000	1,491,273	1,640,000	863,158
Total Cost	8,195,476	12,556,711	17,336,167	7,171,929
C. Unpaid Cost (IDR)				
Depreciation	396,265	245,000	625,000	218,467
Total Cost	396,265	245,000	625,000	218,467
D. Total Cost (B+C) (IDR)	8,591,741	12,801,711	17,961,167	7,390,396
E. Income (A-D) (IDR)	47,365,179	26,650,289	34,819,273	20,667,343

3.3 Comparison of Palm Oil Farming Income in Full Replanting Technique and Underplanting Technique

To compare the income of oil palm farming with full replanting and underplanting techniques, a comparative test analysis was conducted on average using a computer program, namely the SPSS program (statistical package for social science) at a 95% confidence level (t-table α = 5%). The test results are presented in Table 6.

In Table 6, it can be seen that the results of data analysis using SPSS with the test results show a t-count value of 5.638 and a t-table value at α = 5% of 2.001. So the decision was taken to reject H0 and accept H1. This means that the income obtained by farmers who apply the full replanting technique is higher than the income obtained by farmers who apply the underplanting technique.

The variation in income from the two replanting techniques is mainly influenced by the value of income received by farmers. The income from the full replanting technique is better than the underplanting technique, this is due to the variation in age and number of plants on oil palm plantations applied to the two different techniques [18]. The variation in age and number of plants ultimately affects the production of oil palm by farmers. In addition, according to [19] the cost of oil palm plantations incurred in the underplanting technique is also higher than the full replanting technique because on the land of the underplanting technique there are oil palm plants of varying ages, so the maintenance costs are higher.

Table 6 Comparison test on palm oil income in full replanting technique and Underplanting technique

No.	Description	Full Replanting Technique	Underplanting Technique
1.	Average Income (IDR)	47,365,179	34,819,273
2.	Sig. (2 tailed)	0.000	
3.	t-count	5.638	

4 Conclusions

The FFB production results vary between smallholder oil palm plantations in the Muaro Jambi region that use full replanting techniques and underplanting cultivation techniques. This condition is caused by the number of plants and the age of the plants which affect the amount of production produced and the income of farmers. The income of smallholder oil palm plantations using full replanting technology in the research area is higher than the income using underplanting technology (IDR. 47,365,179/farmer/year and IDR. 34,819,273/farmer/year. Proof of the significance test of oil palm plantation income decided that the income in the full replanting technique was significantly better than the income in the underplanting technique.

Compliance with ethical standards

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