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Analysis of Income and Food Security of Oil Palm Farming Households in the BUKAL DISTRICT

Musadianto Madusila[1], Arifuddin Lamusa[1], Made Antara[1], Saiful Darman[2], Muh.Nur Sangadji[2]

[1]Department of Agribusiness Faculty of Agriculture Tadulako University

[2]Department of Agrotechnology Faculty of Agriculture Tadulako University

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***Abstract*: This research aims to: 1) Analyze the factors affecting the level of oil palm production, 2) Analyze the impact of oil palm farming on income, and 3) Analyze the factors affecting the impact of oil palm farming on household food security. This research was conducted in the Bukal District, Buol Regency. The location selection was done purposively. A total of 120 respondents were selected from 12 villages. Estimating factors affecting was analyzed using qualitative and quantitative descriptive methods. Primary data were obtained through interview methods and distributing questionnaires to respondents, while secondary data were sourced from village, district, and regency-level statistical data, as well as data from various relevant institutions. Data processing was conducted manually and through computerization using Microsoft Office Excel 2007, Frontier 4.1, and SPSS programs. This research indicates that, first, the factors influencing the level of oil palm production simultaneously are land area, number of trees, fertilizer, herbicide, and labor. Second, the factors influencing the income level from oil palm farming simultaneously are land area, number of trees, production, fertilizer price, herbicide price, and labor wage. Third, the factors affecting the food security of oil palm farmers are food expenditure and non-food expenditure.**

***Keywords:* Farming, Production, Income, and Food Security.**

I. INTRODUCTION

The agricultural sector plays a significant role in the economic activities of Indonesia, as evident from its substantial contribution to the Gross Domestic Product (GDP), which was approximately 9.40 percent in 2019[1], [2] During economic crises, the agricultural sector has proven to be resilient in the face of economic shocks and has emerged as a reliable driver of national economic recovery[3], [4]

One of the sub-sectors with substantial potential is the plantation sub-sector. Although the contribution of the plantation sub-sector to GDP formation has not been very large, approximately 3.27 percent in 2019, it still ranks as the top sub-sector within the agricultural sector, following the sub-sectors of food crops and fisheries. However, this sub-sector serves as a crucial source of raw materials for the industry, absorbs labor, and generates foreign exchange[5], [6]

The future development of agriculture, especially in the plantation sub-sector, will be influenced by international trade globalization[7], [8] Therefore, attention should focus on competitive flagship commodities in domestic and international markets. One agricultural commodity with significant prospects for increasing per capita income for farmers and serving as a source of foreign exchange for regions and the country is oil palm[4], [9].

Table 1. Land Area and Production of Smallholder Oil Palm Plantations in the Bukal District.

No	Village	Area (Ha)	Production (Ton)
1.	Unone	59	206.50
2.	Winangun	730	2,555
3.	Rantemaranu	1.059	3,685.32
4.	Modo	100	358
5.	Mopu	35	125.30
6.	Potangoan	10	35
7.	Diat	20	70
8.	Yugut	40	140
9.	Mooyong	490	1,754.2
10.	Binuang	60	210
11.	Bukal	6	21
12.	Mulat	118	413
	The year 2020 The year 2019 The year 2018	2,727 2,557 2,541	9,573.32 7,695 9,045.4

The rapid conversion of forest areas in Buol Regency into oil palm plantations, whether by national private plantations or through the plasma pattern involving smallholder farmers, undeniably impacts the environment and the income of households engaged in oil palm cultivation.

The household food security measurement should not only rely on Adequate Energy Intake and Adequate Protein Intake but also consider the proportion of food expenditure, which reflects the household's ability to meet its food needs. Households that spend 70% of their income on food consumption are considered food insecure[10], [11] This determination is based on dimensions and metrics often used to establish the poverty line by using household income levels through the proportion of food expenditure. Poor households typically lose access to adequate food (FAO, 2005). Therefore, the poverty status within households is a condition that makes them vulnerable to food insecurity. Hence, household income levels are a crucial factor in efforts to strengthen food security[12], [13]

Problem Formulation

Based on the previously mentioned research background, several problems can be formulated as follows:

1. What are the factors that affect the level of oil palm production in the research location?

2. What is the income level of farming households in the research location, and what are the factors that affect income from oil palm farming?

3. What is the level of food security among oil palm farming households in the research location, and what are the affecting factors?

Research Objectives

Based on the previously stated problems, the research objectives are formulated as follows:

1. To examine and analyze the factors affecting the level of oil palm production.

2. To examine and analyze the income level of oil palm farming households and the factors affecting it.

3. To examine and analyze the food security status and the factors affecting the food security of oil palm farming households.

II. RESEARCH METHODOLOGY

Research Type

The type of research to be conducted is descriptive research, which includes both qualitative and quantitative methods carried out through a survey. Descriptive research is an attempt to present solutions to existing problems based on data; it presents and then analyzes and interprets the data[14], [15] As the name suggests, the nature of this research is to describe the current state of affairs. It merely portrays the phenomena or situations under study along with their characteristics, reporting what has happened or what is happening. Analytical descriptive research aims to provide systematic and accurate symptoms, facts, or events. Descriptive, in this context, means describing empirical facts in the field with normative analysis so that these facts have meaning and relevance to the research problem being investigated.

Location and Time of Research

The research was conducted in the Bukal District, a district in Buol Regency, Central Sulawesi Province. The selection of this location was based on the assumption that Bukal District is a central area for the development of oil palm plantation businesses, with the largest plantation area compared to other districts in Buol Regency. This research was carried out for approximately 3 (three months), from September to November 2021.

Sampling Method

The selection of Bukal District as the research area was intentionally made based on the following: a) Bukal District is one of the central areas for independent oil palm development in Buol Regency, b) it has the largest area for independent oil palm plantation development, and c) Bukal District has the longest history of independent oil palm plantation development compared to other districts in Buol Regency.

Data Collection Techniques

In social research, data can be collected through various methods and tools. The methods used in data collection for this research are direct interviews and observations. The tools used to support these interview activities include questionnaires and field notebooks. The decision regarding which data collection tool to use is typically determined by the observed variables or the type of data being collected. In other words, the choice of tool aligns with the specific variables being studied[16]

Production Analysis

Production function analysis illustrated the relationship between production and its inputs[17], [18] In this research, the chosen model was the Stochastic Frontier Cobb-Douglas model, estimated using the Maximum Likelihood Estimation (MLE) method through a two-stage process[19], [20]The first stage utilized the Ordinary Least Squares (OLS) method within the MLE framework to estimate all the parameters of production factors, intercept, and variance[21], [22]

The equation for estimating the frontier production function of oil palm farming is as follows:

$$\ln Y = \beta 0 + \beta 1 \ln X1 + \beta 2 \ln X2 + \beta 3 \ln X3 + \beta 4 \ln X4 + \beta 5 \ln X5 + \beta 6 \ln X6 + u$$

Explanation:

Y	= Total oil palm production (kg/ha)
X1	= Number of trees
X2	= Amount of Urea fertilizer used (kg/ha)
X3	= Amount of SP-36 fertilizer used (kg/ha)
X4	= Amount of KCL fertilizer used (kg/ha)
X5	= Amount of Herbicide used (lt)
X6	= Number of Labor (HOK - Hektar of Labor)
β0	= Intercept
βi	= Coefficient parameters, where i = 1, 2, 3, ...n
u	= Error term (technical inefficiency effect in the model).

The expected coefficient values are *β1, β2, β3, β4, β5, β6* > 0. Positive coefficient values imply that an increase in the use of inputs is expected to lead to an increase in oil palm production.

Income Analysis

In a simple mathematical formula, calculating the net income from oil palm farming can be expressed as follows:

$$\pi = TR - TC$$

Explanation:

π	: Net income from oil palm farming
TR	: Gross income from oil palm farming
TC	: Total costs

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To calculate the income of oil palm farming households, the following equation is used:

PTRT = PUT + PNUT

Explanation:

PTRT: Total household income (IDR/month).

PUT: Household income from oil palm farming (IDR/month).

PNUT: Household income from non-oil palm farming activities (IDR/month).

Food Security Analysis

To determine the value of household-level food security, the measurement of the food expenditure and consumption share is used[23], [24]

$$PF = \frac{PP}{TP} \times 100\%$$

Explanation:

PF = Food Expenditure Share

PP = Expenditure on food purchases (IDR/month)

TP = Total Household Expenditure (IDR/month)

Explanation:

a) If the share of food expenditure is < 60% of the total expenditure, then the household is considered food secure.

b) If the share of food expenditure is ≥ 60% of the total expenditure, then the household is considered food insecure.

III. RESULTS AND DISCUSSION

Production Function Analysis

The results of the Cobb-Douglas stochastic production function analysis using Frontier 4.1 with independent variables, namely Number of Trees (X1), Urea Fertilizer (X2), SP-36 Fertilizer (X3), KCL Fertilizer (X4), Herbicide (X5), Labor (X6), and dependent variable, Total Oil Palm Production (Y), were obtained using the OLS (Ordinary Least Squares), MLE (Maximum Likelihood Estimation), and LR (Likelihood Ratio) Test approaches[25], [26]

TABLE II. Results of Production Function Analysis with OLS Frontier

Variable	Coefficient	t-ratio
b0 (Constant)	0.0268	0.1496
b1 (Number of Trees)	0.0371	2.7154
b2 (Urea Fertilizer)	0.2055	5.1819
b3 (SP-36 Fertilizer)	0.6067	11.555
b4 (KCL Fertilizer)	0.1255	3.6733
b5 (Herbicide)	0.0087	0.1684
b6 (Labor Force)	0.0076	1.9224
Adjusted R^2	0.527	

Based on Table 2, it can be seen that the estimation of the production function using OLS (Ordinary Least Squares) results in an R-squared value of 0.527, or, when expressed as a percentage, 52.7%. This means that the estimated factors affecting the production function can be explained by the independent variables to the extent of 52.7%, and the remaining variance is explained by errors or other variables not included in this study[27], [28]

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To determine The best performance among the factors affecting production can be ascertained through estimation using the Maximum Likelihood Estimation (MLE) approach with a confidence level of 95%, α = 5%, and a critical t-table value of 2.446[29], [30] Below is the estimation table for the production function using MLE in oil palm farming.

TABLE III. Results of Production Function Estimation Analysis with Frontier MLE

Variable	Coefficient	t-ratio	Remarks
b0 (Constant)	-0.0845	-0.5608	
b1 (Number of Trees)	0.0463	5.3219	*
b2 (Urea Fertilizer)	0.5551	13.0802	*
b3 (SP-36 Fertilizer)	0.2821	6.9408	*
b4 (KCL Fertilizer)	0.0912	3.3637	*
b5 (Herbicide)	-0.0087	-0.2436	Ns
b6 (Labor)	0.0041	1.3659	Ns
Log Likelihood	175.331		
LR test of one side error	54.713		

Remarks:

- Significance at α = 5%
- Ns = Not significant

Based on Table 3. it can be observed that the LR Test of one-sided error from the stochastic frontier production function results is 54.713. This indicates that the null hypothesis (H_0) is rejected, implying the presence of inefficiency cases because the LR Test result (54.713) is greater than the critical value of Kode Palm (5.138) with the degrees of freedom (df) obtained from the number of restrictions being 2, at a confidence level of 95% (α = 5%).

TABLE IV. Total Income from Oil Palm Farming

No.	Description	Notation	Value
1.	Cost Items: 1. Fixed Costs: - Tax - Depreciation - Total 2. Variable Costs: - Urea Fertilizer Cost - SP-36 Fertilizer Cost - KCL Fertilizer Cost - Herbicide Cost - Labor Cost - Total		 IDR 4,001,000.00 IDR 93,466,500.13 IDR 97,467,500.13 IDR 175,072,000 IDR 107,202,500 IDR 247,575,000 IDR 85,960,000 IDR 569,869,300 IDR 1,185,678,800
1	Total Cost (TC)		IDR 1,283,146,300.13
2	Revenues: Production X Price	TR	IDR 6,626,976,000.00
3	Income	TR-TC	IDR 5,343,829,700
4	Profitability Ratio (R/C)	TR/TC	5.16

By examining the table above, it can be explained that the total income from oil palm farming at the research location is relatively high, amounting to IDR 5,343,829,700/household/year, or an average of IDR 44,531,914/household/year. It is profitable, as indicated by the value of R/C being more significant than 1 (R/C > 1).

TABLE V. Total Farm Household Income

	UT Palm Income (IDR)	Non-UT Palm Income (IDR)	Total Income (IDR)
Σ (Sum)	5,343,829,700	3,794,040,000	9,137,869,700
x̄ (Mean)	44,531,914	31,617,000	76,148,914

PTRT = PUT + PNUT

PTRT = IDR 5,343,829,700,- + IDR 3,794,040,000,-

PTRT = IDR 9,137,869,700,-

Based on the calculations above, it can be determined that the income from oil palm farming is IDR 5,343,829,700, and the income from non-oil palm farming activities is IDR 3,794,040,000. Therefore, the total annual income of farm households is IDR 9,137,869,700, with an average of IDR 76,148,914/household/year.

TABLE VI. Multicollinearity Test Results for Farm Household Food Security

Research Variable	Tolerance	Description	VIF	Description
Income (X1)	0.305	> 0.10 (Good)	3.232	< 10.00 (Good)
Rice Price (X2)	0.366	> 0.10 (Good)	2.546	< 10.00 (Good)
Sago Price (X3)	0.321	> 0.10 (Good)	1.122	< 10.00 (Good)
Vegetable Price (X4)	0.590	> 0.10 (Good)	1.698	< 10.00 (Good)
Fish Price (X5)	0.516	> 0.10 (Good)	1.942	< 10.00 (Good)
Cooking Oil Price (X6)	0.319	> 0.10 (Good)	3.140	< 10.00 (Good)
Dependency (X7)	0.383	> 0.10 (Good)	2.615	< 10.00 (Good)

Based on the results of the multicollinearity test in Table 6, the tolerance values for all independent variables are more significant than 0.10, and the calculated Variance Inflation Factor (VIF) values are less than 10.0. Therefore, it can be concluded that there is no multicollinearity among the independent variables in the regression.

TABLE VII. Proportion of Expenditure among Respondent Farm Households

Expenditure Category	Amount (IDR/Month)	Proportion (%)
Food Expenditure	IDR 268,382,000	62.28%
Non-Food Expenditure	IDR 162,550,000	37.72%
Total Expenditure	IDR 430,937,000	100%

Source: Data processed, 2020

The total expenditure is the sum of food and non-food expenditure. The total monthly expenditure for all respondents in this study is IDR 430,937,000/household/month or IDR 3,591,141.67/household/month. The table above shows that the total household expenditure on food is IDR 268,382,000, which accounts for 62.28% of the total expenditure, while the non-food expenditure is IDR 162,550,000, which accounts for 37.72%.

IV. CONCLUSION

Based on the results of the hypothesis testing conducted in the previous chapter, the following conclusions can be drawn:

1. The production factors of the Number of Trees, Urea Fertilizer, SP-36 Fertilizer, KCL Fertilizer, Herbicide, and Labor collectively have an influence on Production. Partially, the production factors of the Number of Trees, Urea Fertilizer, SP-36 Fertilizer, and KCL Fertilizer have a significant impact on production. However, the production factors of Herbicide and Labor do not have a significant effect on oil palm production at the research location. The most responsive variable is Urea Fertilizer, as the most significant coefficient value indicates.

2. The total income of farming households in the research location is relatively high, amounting to IDR 9,137,869,700/year, or an average of IDR 76,148,914/household/year. The contribution of income from oil palm farming to the total household income is IDR 5,343,829,700/year, with an average of IDR 44,531,914.17/household/year, accounting for 58.48% of the total income. Non-farming income totals IDR 3,794,040,000/year, with an average IDR 31,617,000, representing 41.52% of the total income. The difference between total farming income and total non-farming income is IDR 1,549,789,700/year, or an average of IDR 12,914,914.17/household/year, accounting for 16.96%. The production factors, including the number of trees, the price of urea fertilizer, the cost of SP-36 fertilizer, the price of KCL fertilizer, the price of herbicide, and labor wages, have a significant impact, both collectively and partially, on the income from oil palm farming at the research location, with the number of trees being the most responsive variable with the most significant coefficient value.

3. Farming households of oil palm growers in the research location are still categorized as food insecure, as indicated by the proportion of food expenditures exceeding 60%, averaging 62.28%. The factors that collectively and partially affect the food security of oil palm farming households include income, rice prices, sago prices, vegetable prices,fish prices, cooking oil prices and the number of family dependents.

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