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Assessing Production and Income Risks in Oil Palm Farming and Farmers' Mitigation Strategies in Puriala of Southeast Sulawesi

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***Abstract*: The objective of this research is to ascertain the magnitude of production and income risks encountered by smallholder oil palm farmers, as well as the strategies necessary for these farmers to overcome or mitigate these risks. The study was conducted in Puriala Village, Puriala Subdistrict, Konawe District, Southeast Sulawesi. The sampling technique utilized was census method. The research spanned from November 2022 to June 2023. The determination of respondents was also carried out using the Non-Probability Sampling method, involving a total of 20 farmers engaged in cultivating and producing oil palm. Data analysis methods included income analysis, coefficient of variation (CV) analysis, and descriptive analysis. The findings of this study reveal that the average income of farmers in Puriala Village is Rp 934,010 per hectare per month. The production risk, indicated by a Coefficient of Variation (CV) value of 0.225, and the income risk, with a CV value of 0.26, suggest that oil palm farming in Puriala Village carries low production and income risks.**

***Keywords*: income, oil palm, production, risk, smallholder, strategy.**

1. Introduction

Oil palm cultivation has emerged as a crucial agricultural sector in Indonesia, significantly contributing to the country's economic landscape. Since its development in 1986, the industry has evolved from state and private enterprise assistance to the flourishing of independent smallholdings [1]. These developments, however, have brought unique challenges, especially in terms of productivity and market pricing. Despite these challenges, the sector's impact is profound, involving over 2.1 million households [2] and contributing 3.47% to Indonesia's GDP [3]. This growth mirrors Indonesia's broader agricultural strategy, which positions oil palm as a key driver for rural employment and poverty alleviation. Nevertheless, the inherent production and price risks associated with this crop underscore the need for effective risk management strategies to ensure sustainable growth and economic stability in this vital sector.

In the context of Southeast Sulawesi Province, oil palm cultivation holds a distinct significance. This region, characterized by its diverse topography and climatic conditions, presents a unique environment for oil palm growth. Oil palm is not a priority crop in the province [4], but there has been an expansion in oil palm plantations [5], [6], contributing to the province's agricultural output and economic development. This expansion is reflective of the province's strategic efforts to capitalize on the crop's economic potential. Despite facing challenges such as land availability and environmental concerns, the province continues to explore sustainable approaches to enhance oil palm productivity. These efforts not only aim to strengthen the local economy [7] but also align with national objectives to strengthen Indonesia's position as a leading global producer of palm oil.

Agriculture, inherently subject to various risks [8], faces unique challenges in oil palm farming [7]. These risks, both natural and market-driven, significantly influence production and profitability. Natural risks include climatic variations, pest infestations, and disease outbreaks [8], which can adversely affect yield. Market risks [9] involve fluctuations in global palm oil prices, influenced by international demand, policy changes, and competition. In Southeast Sulawesi, these risks are compounded by regional factors like weather patterns and local market dynamics. Understanding and managing these risks is crucial for the stability and sustainability of oil palm cultivation in this region.

In the context of oil palm farming, the risks can be distinctly categorized into production (or farming) risks and income risks [1], [9]. Production risks primarily involve factors affecting the physical cultivation of oil palms, such as soil fertility, pest control, and efficient management of plantation resources. These risks directly impact the yield and quality of the oil palm fruits. Income risks, on the other hand, are associated with the financial aspects of oil palm farming. These include price volatility in the palm oil market, changes in input costs, and fluctuations in demand. Both types of risks are intricately linked, as changes in production can directly influence income, and vice versa. Effective management of these risks is essential to ensure the economic viability and sustainability of oil palm farming enterprises.

The need to manage risks [1], [8] in both production and income is paramount in oil palm farming. Effective risk management strategies can mitigate the adverse effects of unpredictable factors [11], [12], ensuring a more stable and

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sustainable agricultural practice. These strategies involve adopting advanced agricultural practices, diversifying income sources, and implementing financial risk management tools. Such measures not only safeguard against yield and market uncertainties but also contribute to the long-term economic resilience of farmers.

Despite the significance of risk management in oil palm farming, there is a noticeable gap in comprehensive research focusing on both production and income risks in Southeast Sulawesi's context. This gap highlights the need for a detailed study that not only quantifies these risks but also explores effective mitigation strategies in accordance with local conditions. Such research is vital to provide empirical evidence and practical guidance for farmers, policymakers, and stakeholders in the region. This study aims to fill this gap, offering insights into the dynamics of risk management in oil palm farming within Puriala Village, Southeast Sulawesi, thereby contributing to the broader understanding and sustainability of this critical agricultural sector.

2. Materials and Methods

This study was conducted in Puriala Village, Puriala Subdistrict, Konawe District, Southeast Sulawesi. The study location was chosen purposively for its significant population of oil palm farmers. The research period spanned from November 2022 to July 2023. The population comprised 20 oil palm farmers from the village, with the sample selected through a non-probability, saturated (census) sampling method. This method was appropriate due to the small population size.

Primary data were gathered directly from oil palm farmers using structured interviews and questionnaires. Secondary data were collected from relevant institutions, including previous research journals, articles, and internet sources.

Data collection techniques involved direct interviews with farmers using research questionnaires to gather information on production costs, harvest yields, transportation processes, and sales prices of Fresh Fruit Bunches (FFB). The study utilized both descriptive and quantitative analysis methods. Cost and returns analysis was conducted using the formula : Income (I) = Total Revenue (TR) - Total Cost (TC) [13], [14]. Production costs were calculated as the sum of variable costs (TVC) and fixed costs (TFC). The coefficient of variation (CV) [10], [15], [16] was used to determine the production and income risks faced by farmers.

3. Results and Discussion

A. Oil Palm Farming

Oil palm farming in the study village is a notable agricultural activity. The palm trees in the village are harvested one to two times a month, beginning three years after planting. Interviews with farmers revealed that harvest times sometimes precede the optimal harvesting period for Fresh Fruit Bunches (FFB) or *Tandan Buah Segar* (TBS), leading to variable production levels.

Farmers in the village typically obtain small to medium-sized oil palm seedlings, often provided by local government initiatives. These seedlings are not given freely but under specific conditions, such as land ownership and readiness for planting. The seedlings are planted in polybags filled with sieved topsoil. Careful maintenance, including the use of organic and NPK fertilizers and regular watering, is essential for the seedlings' growth. After approximately 3-4 months, when the seedlings have developed 4-5 leaves, they are ready for transplantation.

Respondent farmers generally use single fertilizers, like urea, and compound fertilizers, such as NPK and Phonska. Fertilization is typically done twice a year, at the beginning and end of the rainy season, by spreading the fertilizer around 1-3 meters from the palm trunk. The average fertilization cost is about IDR 120,000 per hectare.

Weed control is managed using herbicides, with farmers commonly using Gramaxone and Rambo Peak, at a rate of 3 liters per hectare. These herbicides take 1-2 days to effectively eliminate weeds by disrupting their physiological processes. Spraying is conducted using a Sprayer/Tank.

Harvesting is usually done when the plant is over three years old. Most farmers use tools like *dodos* (chisel-like tool) for pruning fronds, facilitating the harvesting of oil palm fruit. The harvesting process often requires additional labor due to its labor-intensive nature. The average labor cost for harvesting is IDR 170,000 per hectare. Post-harvest, the transportation of FFB to oil palm factories in other villages, is conducted using loading equipment, carts, and trucks.

B. Costs and Returns

Agricultural farming is a human activity focused on utilizing natural resources to maximize production, ultimately aiming to enhance farmers' income. Income from farming is derived from the difference between the revenues earned and the expenses incurred. Revenues come from the sale of cultivated crops, while costs include all expenditures in a single production cycle, such as production inputs, labor wages, land taxes, and depreciation of equipment. The analysis of costs and income in oil palm farming can be observed in Table 1.

Table 1
Cost and Returns of Oil Palm Farming, 2023

Items	Value (Rp)
A. Variable cost	
• Fertilizer	56,250
• Herbicide	660,000
• Paid labor	340,000
• Total variable cost	1,056,250
B. Fixed cost	
• Depreciation	46,807
• Tax	5,000
• Total fixed cost	51,807
C. Total cost	1,108,057
D. Returns	
• Revenue	2,042,067
• Net returns (Revenue-Total Cost)	934,010

Table 1 shows that the average production of respondent farmers is 1,021 kg/ha/month at an average unit price of IDR 2,000/kg/month, resulting in average revenues of IDR 2,042,067/ha/month. Variable costs amount to IDR

1,056,250/ha/month. Labor costs are IDR 340,000/ha/month, encompassing fertilization, harvesting, and transportation. Fixed costs incurred by respondent farmers are IDR 51,807/ha/year, including equipment depreciation and land tax. The total costs amount to IDR 1,108,057/ha/month, and the total income is IDR 934,010/ha/month.

C. Risks Facing Smallholder Farmers

Oil palm farming in the study village faces various risks that pose challenges to palm oil farmers. These include unpredictable weather, production processes, and market dynamics. Natural factors are the most impactful on production and income, while other risks include the provision of subsidized fertilizers, pests, diseases, and fluctuating prices of Fresh Fruit Bunches (FFB) in line with Crude Palm Oil (CPO) market rates. However, farmers in P find palm oil farming profitable considering the costs incurred and the resulting production increase.

Farmers face issues such as capital, fertilizer availability, production processes, and marketing. Challenges include difficulty in meeting loan requirements from banks, delays in purchasing fertilizer due to limited market availability, mismatches in labor timing affecting production outcomes, lack of timely action against disease symptoms in plants, harvest labor not considering fruit maturity, and inadequate equipment prolonging the harvest process. Marketing to palm oil factories involves risks such as long queues and transport issues.

According to Kartikaningsih [17], farm equipment resources support the operation of agriculture. The development of these resources aims to improve productivity, quality, and value addition. For instance, using tractors for soil cultivation reduces manual labor and enhances efficiency. Farmers in Puriala Village face risks due to insufficient subsidized fertilizers, improper herbicide choices, and limited equipment availability. The lack of subsidized fertilizers forces them to incur additional costs to purchase non-subsidized fertilizers from nearby locations.

Farmers in the village also experience risks due to unpredictable weather, which can lead to reduced palm weight and low fruit production, labor errors in production processes, and pest attacks. The most common and impactful risks are weather-related and pest-related. This condition is supported by a study by Benny et al. [18] that climate (temperature, humidity and rainfall) significantly influenced oil palm productivity.

In addition to production risks, farmers also face marketing risks such as long queues for selling fruits to companies, fluctuating FFB prices, and price reductions if fruit quality does not meet company standards. FFB prices are set by stakeholders as per regulations.

Interviews with farmers in the village also reveal risks due to high-interest loans from local lending institutions and reliance on middlemen for urgent financial needs, leading to repayment through harvest proceeds, often leaving farmers with little profit. This result is in line with the findings of research by Saediman et al. [19] regarding the conditions facing rice farmers in capital shortages and hence in accessing credit from various sources.

D. Production Risks

The agricultural risks in oil palm farming in Puriala Village consist of production and income risks. These risks are analyzed using the coefficient of variance, where a lower coefficient value indicates low variability in the average distribution value, depicting smaller risks faced. The analysis of oil palm production risks in Puriala Village can be observed in Table 2.

Table 2
Analysis of Production Risks, 2023

No.	Description	Value
1	Yield (kg/Ha/Month)	1,021
2	Standard Deviation (kg/Ha/Month)	229.6
3	Coefficient of Variation (CV)	0.225

Table 2 indicates that the average oil palm production of farmers in Puriala Village is 1,021 kg/ha/month. From this production calculation, the standard deviation for oil palm is determined to be 229.6 kg/ha/month. The coefficient of variation, obtained by comparing the average production with the standard deviation, is 0.225. This value is less than 0.5 ($0.225 < 0.5$), indicating that the production risk for oil palm farmers in the village is considered low. According to the farmers, risks such as a shortage of subsidized fertilizers are still manageable.

E. Income Risks

Income risk in oil palm farming in the village is analyzed using the coefficient of variance. A smaller coefficient of variation value indicates low variability in the average distribution, suggesting a lower risk level. The analysis of income risk for oil palm farmers is presented in Table 3.

Table 3
Analysis of Income Risks, 2023

No.	Description	Value
1	Net Returns (Rp/Ha/Month)	934,010
2	Standar Deviasi (Rp/Ha/Month)	243,002
3	Coefficient of Variation (CV)	0.260

Table 3 shows that the average income of oil palm farmers in the study village is IDR 934,010 per hectare per month. From this income analysis, the standard deviation for oil palm income is calculated to be IDR 243,002 per hectare per month. The coefficient of variation, derived from comparing the average income to the standard deviation, is 0.260, which is less than 0.5 ($0.260 \leq 0.5$). This analysis indicates that the income risk for oil palm farmers is categorized as low. Farmers perceive risks such as fluctuating labor costs and FFB sales to factories as controllable by managing farming expenses and enhancing productivity. A coefficient of variation (CV) value of ≤ 0.5 implies that farmers are likely to break even or profit, despite the increasing production risks they bear.

The analysis indicates that the income risk for oil palm farmers in Puriala Village is categorized as low. This is contrast to research by Kurniati et al. [20] that found income risk of citrus farming in Sambas is very high. Farmers in the study village acknowledge risks like variable labor costs and

fluctuating revenues from FFB sales to factories. However, these issues are manageable by focusing on farming expenditure and improving productivity.

Fauziyah [21] suggests that the income structure of farmers influences their risk management behavior. Farmers with higher incomes can implement various strategies to reduce risks, and vice versa. The income of oil palm farmers in Puriala Village is considered profitable. Profitability is analyzed using the Revenue Cost (R/C) ratio, which compares the total production value with the total costs incurred in farming. This ratio also assesses the feasibility of a farming venture. An R/C ratio ≥ 1 indicates a viable farming operation worth developing, ≤ 1 suggests it's not feasible, and $= 1$ means the operation breaks even. The average R/C ratio for oil palm farming by respondent farmers in Puriala Village, Puriala Subdistrict, Konawe Regency can be seen in Table 4.

Table 4
R-C Ratio of Smallholder Oil Palm Farming, 2023

No.	Description	Value
1	Revenue (Rp/Ha/Bulan)	2,042,067
2	Total Biaya (Rp/Ha/Bulan)	1,108,057
3	R/C Ratio	1.84

Table 4 reveals that the calculated Revenue Cost (R/C) ratio for oil palm farming is 1.84. Based on the criterion that an R/C ratio greater than 1 indicates profitability, the farming activities of the respondent farmers are profitable. With an R/C Ratio of 1.84, the farming venture is deemed viable as it generates a revenue of IDR 1,840 for every IDR 1,000 spent at the end of production.

F. Risk Mitigation

Farmers in Puriala Village frequently encounter issues related to climate and subsidized fertilizers. Unpredictable weather [22], [23], especially continuous rainfall, leads to various pests and diseases affecting plants and damages roads to palm oil factories. To address these issues, farmers are advised to conduct direct observations of their crops. Immediate action with appropriate treatments is recommended upon signs of pest and disease infestation. Regarding subsidized fertilizers, farmers can request reserve stocks from their cooperative leaders to avoid shortages during fertilization periods. Assistance from local government might be sought to facilitate the formation of farmer groups and manage subsidized fertilizer distribution.

Another risk faced by farmers is the delay in processing oil palm fruits at the factory. This agrees to findings of research by Asminar et al. [24] that such a delay is often due to long queues of trucks waiting outside the factory, which can compromise the quality standards of the Fresh Fruit Bunches as agreed upon by the company and farmers, especially if middlemen are late in transporting the fruits. These delays are sometimes caused by farmers not adhering to the factory's scheduled fruit intake, resulting in long queues. To mitigate this issue, farmers should adhere to harvest and transport schedules to ensure timely delivery of fruits to the factory. It is also crucial to establish a more systematic approach to scheduling harvest and transportation to minimize delays and ensure optimal fruit quality. Additionally, strengthening institutional frameworks [25] can help communicate farmers' challenges to the palm oil factory industry. The price of FFB/TBS price is determined centrally, following the stipulations in the Ministry of Forestry and Plantation Decree No. 627 of 1998, set by a team consisting of plantation departments, company representatives, and farmer representatives [24]. To maximize prices, farmers should focus on the quality and standards of FFB/TBS to achieve higher sales results.

4. Conclusion

Oil palm farmers in Puriala Village face production risks including climate issues, subsidized fertilizer shortages, pest and disease infestations, and damaged roads to palm oil factories, all contributing to decreased palm oil production. Income risks involve fluctuating prices and delays in transportation by middlemen, resulting in reduced palm fruit weight.

To mitigate production risks, Puriala Village oil palm farmers need to prepare appropriate treatments for pests and diseases. For fertilizer issues, they should request reserve stocks from cooperative leaders or purchase from stores in the district capital. To mitigate income risks, farmers should focus on adhering to harvest and transportation schedules to ensure timely fruit delivery to factories.

General mitigation strategies that can be employed include climate adaptation, fertilizer management, integrated pest and disease management, infrastructure improvement, market and transportation coordination, and farmer education and support.

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