

Added value of palm sugar processing by the Buhung Lali forest farmers group in South Sulawesi, Indonesia

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Department of Forestry, Faculty of Forestry, Universitas Hasanuddin. Jl. Perintis Kemerdekaan Km. 10, Makassar 90245, South Sulawesi, Indonesia.
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Abstract. Lestari PEE, Syahidah, Mujetahid A. 2026. Added value of palm sugar processing by the Buhung Lali forest farmers group in South Sulawesi, Indonesia. *Asian J For* 10 (1): r100135. <https://doi.org/10.13057/asianjfor/r100135>. Non-Timber Forest Products (NTFPs) play a vital role in sustainable forest management by providing economic benefits while maintaining ecosystem health. Among these, the sugar palm (*Arenga pinnata*) represents a high-value NTFPs that is predominantly managed using traditional methods by the community of Bukit Harapan Village, Bulukumba District, South Sulawesi, Indonesia, particularly members of the Buhung Lali Forest Farmers Group (FFG). This study aims to describe the production process of palm sugar, from sap tapping to the final products, and to analyze the added value generated from processing sap into granulated palm sugar and liquid palm sugar. Data were collected through direct observation, structured interviews, and documentation of production activities. Analysis using the Hayami Method reveals that granulated palm sugar provides an added value of IDR 4,800/kg with a profit rate of 98%, whereas liquid palm sugar yields an added value of IDR 600/kg with a 66% profit rate. The higher added value and profitability of granulated sugar are primarily due to its higher market price and the lower interest among KTH members in producing liquid sugar, which is less favored in the local market. Furthermore, labor requirements differ between the two products, with granulated sugar production being more capital-intensive and efficient in labor use, while liquid sugar production relies more on manual labor. These findings underscore the economic potential of diversifying NTFPs-based products and optimizing production processes. Promoting high-value products like granulated palm sugar can enhance the income of small-scale farmers and entrepreneurs, support local agroindustries, and contribute to sustainable forest resource management. Overall, this study highlights the importance of integrating traditional knowledge, market strategies, and value-added processing to strengthen both rural livelihoods and environmental sustainability.

Keywords: Added value, granulated palm sugar, Hayami method, liquid palm sugar, non-timber forest products

Abbreviations: FFG: Forest Farmers Groups, HOK: Man-days, NTFPs: Non-Timber Forest Products

INTRODUCTION

Non-Timber Forest Products (NTFPs) are a strategic component in sustainable forest resource management (Shrestha et al. 2020; Pasaribu et al. 2021; Talukdar et al. 2021; Zhang et al. 2021; Derebe and Alemu 2023; Ichsan 2024; Latifah et al. 2025). Globally, NTFPs are recognized as an alternative form of forest utilization beyond timber because they can provide economic benefits while simultaneously reducing the rate of ecosystem degradation. Unlike timber exploitation, which has the potential to cause significant ecological damage, NTFPs offer a more environmentally friendly source of livelihood for communities living around forest areas (Nghonda et al. 2023; Panda et al. 2024; Asamoah et al. 2025; Abdullah et al. 2026). Forest sustainability can be maintained through NTFP management because it is not only economically beneficial but also does not negatively affect surrounding forest areas (Casper et al. 2020). One NTFP commodity with high economic value that is widely managed by local communities is the sugar palm.

Sugar palm are mostly cultivated by smallholder farmers and have not yet been developed on a large industrial scale. Nevertheless, sugar palm cultivation and

processing serve as an important source of income, especially for palm sugar producers. Sugar palm plants produce several derivative products. In addition to sap that is processed into granulated palm sugar and liquid palm sugar, the fruit can be processed into *kolang-kaling*, while palm starch is also commonly utilized to produce palm flour (Nawawi et al. 2025). Sugar palm is a forest plant that grows and produces naturally, so it does not require intensive maintenance such as fertilization or irrigation, and it can grow well in rural areas without modern agricultural technology interventions (Aidah et al. 2024; Harahap et al. 2025). Sugar palm sap can be processed into granulated palm sugar and liquid palm sugar, two products that have different characteristics, market segments, and added value potential. This product diversification presents an important opportunity to increase the income of farmers and small-scale businesses based on local resources.

Value added is an important indicator for assessing the extent to which the production process generates economic improvement from raw materials to final products for business actors (Nurjanah et al. 2022). In the context of rural agroindustry, value-added analysis is essential to determine how far processing activities can increase the economic value of a commodity. One commonly used

approach is the Hayami Method, which enables the calculation of economic contributions from raw materials to final products across various commodities (Arifani and Mahfudz 2024). A comparison of value added between granulated palm sugar and liquid palm sugar has important implications for agroindustry actors, as it highlights differences in the economic contribution of each product. This can serve as a basis for product diversification strategies, improving business efficiency, and expanding market access (Janah and Adinasa 2024; Burhanudin et al. 2025).

Processing sugar palm sap into granulated palm sugar or liquid palm sugar generates higher added value compared to selling raw sap, because the processing activities produce significant additional economic value for agroindustry actors and increase farmers' household income. This reflects the importance of the value-added concept in NTFPs-based agroindustry as an indicator of the economic contribution of a commodity (Maharani et al. 2025). The novelty of this study lies in its comparative analysis of the value added in palm sugar processing across two product forms granulated palm sugar and liquid palm sugar, within the same production unit. In contrast to previous studies, which generally focus on a single product type or adopt a descriptive approach, this study employs a quantitative method using the Hayami approach to directly compare the magnitude of value added, income distribution, and economic efficiency of each processed palm sap product. Thus, this study not only provides an assessment of value added but also establishes a stronger analytical basis for evaluating the performance of product diversification in palm sugar processing at the farmer group level. The findings are expected to serve as a basis for decision-making in formulating more efficient and sustainable strategies for the development of NTFPs-based agroindustry, particularly in community-level palm sap processing.

MATERIALS AND METHODS

Study area

This study was conducted in Forest Farmers Groups (FFG) Buhung Lali, Bukit Harapan Village, one of the villages in Gantarang Sub-district, Bulukumba District, South Sulawesi, Indonesia, located 15 km from the capital of Bulukumba with an area of 11.33 km² or about 6.53% of the total area of Gantarang Sub-district and a population of 3,386. Ecologically, this area is located at an altitude of <500 metres above sea level with rainfall ranging from 2,000 to 2,500 mm/year and an air temperature ranging from 23 to 27°C. To illustrate the conditions and boundaries of the administrative area, the following is a map of the Bukit Harapan Village Administration, Gantarang Subdistrict, Bulukumba District, which shows the village boundaries, road network, and geographical location of the area. More specifically, it can be seen in Figure 1.

Data collection

Data were collected through field surveys, interviews, questionnaires, and document review. Field surveys were conducted to identify the actual conditions of sugar palm sap management in the field, including direct observation of sugar palm plantations to assess their existing potential. Interviews and questionnaires were administered directly to farmers to obtain information related to sugar palm sap processing practices, production potential, and the development of sugar palm sap-based enterprises.

The population in this study consisted of 102 members of the FFG. However, only 12 members were identified as active farmers involved in sap tapping, palm sugar production, and marketing. The remaining members were excluded because they were inactive or no longer involved in activities related to palm sugar production. Given the limited number of active farmers, a census approach was applied by including all 12 active farmers to provide an in-depth representation of the value added from palm sugar processing. Therefore, this study is exploratory and case-based, aiming to provide a comprehensive understanding of value addition in palm sugar processing within the Buhung Lali FFG.

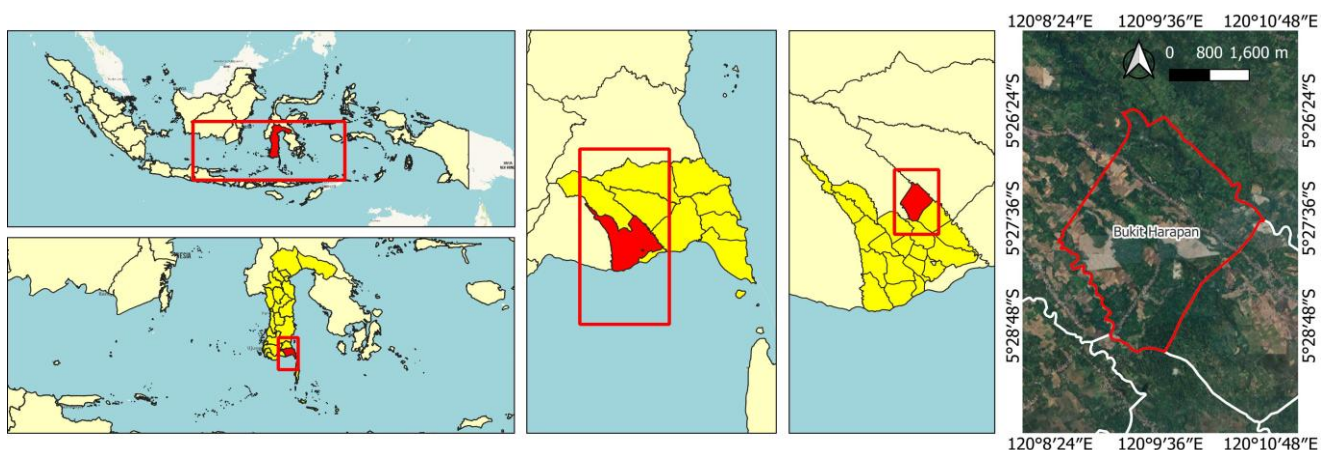


Figure 1. Map of the research location in Bulukumba, South Sulawesi, Indonesia

This study used two types of data: primary data and secondary data. Primary data were collected regarding sugar palm sap processing enterprises, including revenue, expenditures, production costs, product prices, labor, and profits for agroindustry actors who process sap into granulated palm sugar and liquid palm sugar. Secondary data were obtained from literature sources such as books, academic journals, and other supporting references related to this research. The data analysis methods used in this study included value-added analysis using the Hayami method, as well as total cost, revenue, and income analysis models to determine income from palm sugar processing.

Data analysis

Added value

Added value is the difference between commodities before undergoing processing and after becoming finished goods. The amount of added value obtained comes from subtracting the output value, other input values, and raw material values (Nurdasanti et al. 2021). Added value is the increase in the value of a commodity due to undergoing processing, transportation, or storage in a product. The processing of palm sap into palm sugar and liquid palm sugar can be analysed using the Hayami method. The processing of palm sap into palm sugar and liquid palm sugar at FFG Buhung Lali can be analysed using the Hayami method. The procedure for calculating added value using the Hayami method can be seen in Table 1.

In calculating added value, the category of an agroindustry can be determined based on its added value ratio, namely whether it falls into the low, medium or high added value category. The added value category is determined using the following criteria: if the ratio value <15% means low added value, if the ratio value is between 15-40%, it means moderate added value, and if the added value ratio is >40%, it means high added value (Ramadhani et al. 2022). Another criterion is that if the added value is >0, it means that palm sap provides added value, and if the added value is <0, it means that palm sap does not provide added value (Aji et al. 2018).

Total costs

Total costs are all costs incurred directly and indirectly by farmers to carry out palm sugar business activities. Total costs are the total amount of production costs incurred. Mathematically, total costs can be formulated as follows (Pramudya et al. 2023):

$$TC = FC + VC$$

Where, TC is Total Cost (IDR), FC is Fixed Cost (IDR), and VC is Variable Cost (IDR).

Revenue

Revenue is the total income earned by a business unit from the sale of its output (Suryani et al. 2021). Total Revenue (TR) is the total revenue received by producers from the sale of their output. Total revenue is obtained from the product of the unit price and the quantity of output, or can be written using the following equation (Sitinjak and Sinaga 2022):

$$TR = Q \times P$$

Where, TR is Total Revenue (IDR), Q is Total Production (kg), and P is the Selling Price of Production (IDR).

Income

Income is all the money a person gets for their work in the production process. This payment can be in the form of wages, interest, rent, or profit, depending on the factors of production involved in the production process (Sa'adah and Jannah 2022). Basuki et al. (2023) state that income is the amount of earnings received by producers for their work performance during a certain period, whether daily, weekly, monthly, or annually. Business activities will ultimately generate income in the form of monetary value received from the sale of goods minus the costs incurred as in the following formula:

$$I = TR - TC$$

Where, I is Income (IDR), TR is Total Revenue (IDR), and TC is Total Cost (IDR).

Revenue-Cost (R/C) ratio analysis

The financial feasibility of palm sugar processing was evaluated using the Revenue-Cost (R/C) ratio, a widely accepted indicator in agricultural and agro-industrial studies (Akhri et al. 2025; Hulopi et al. 2025). The R/C ratio measures the relationship between total revenue generated from a production activity and the total costs incurred, including both fixed and variable costs. It is calculated using the following formula:

$$R/C \text{ Ratio} = \text{Total revenue (TR)} / \text{Total cost (TC)}$$

Where, TR is Total Revenue (IDR), and TC is Total Cost (IDR).

The results of the calculation are interpreted based on the following criteria: $R/C > 1$, the business is profitable, $R/C = 1$, the business breaks even and $R/C < 1$, the business incurs a loss (Yelfiarita et al. 2022).

Table 1. Procedure for calculating the added value of a product using the Hayami method (Hayami et al. 1987)

Variable output, input, and price values	Value
Output (kg)	A
Raw Material (l)	B
Labour (HOK)	C
Conversion Factor	$D = A/B$
Labour Coefficient (HOK/kg)	$E = C/B$
Output Price (IDR/kg)	F
Revenue and Profit	
Labour Wages (IDR/HOK)	G
Raw Material Prices (IDR/l)	H
Output Value (IDR)	$I = D \times F$
a. Added Value (IDR/kg)	$J = I - H$
b. Added Value Ratio (%)	$K = (J/I) \times 100\%$
a. Labour Income (IDR/kg)	$L = E \times G$
b. Labour Share (%)	$M = (L/J) \times 100\%$
a. Profit (IDR/kg)	$N = J - L$
b. Profit Margin (%)	$O = (N/J) \times 100\%$
Remuneration for Production Factors	
Margin (IDR/kg)	$P = I - H$

RESULTS AND DISCUSSION

Added value of granulated palm sugar and liquid palm sugar

The analysis method used to determine the added value obtained from processing palm sap into granulated palm sugar and liquid palm sugar is the Hayami model added value calculation method. The added value calculation is carried out on the palm sap processing process with the aim of measuring the amount of added value that occurs as a result of the processing of palm sap into granulated palm sugar and liquid palm sugar that is ready for marketing.

Added value is obtained from the process of processing palm sap into processed products. The processed products produced in this process are granulated palm sugar and liquid palm sugar. The initial calculation basis is the variable value to determine the added value for one production process, such as output, input, labor, average labor wages, raw material prices and non-raw material costs per unit of material.

Table 2 shows that the added value generated from granulated palm sugar and liquid palm sugar has a very significant difference, where the added value generated from granulated palm sugar is IDR 4,800 and the added value from liquid palm sugar is IDR 600. The details of the input price, output price, output value, added value and added value ratio of granulated palm sugar and liquid palm sugar can be seen in Figure 2.

The average price of raw materials for granulated palm sugar and liquid palm sugar in the study area is IDR 3,000/l. The average output price of granulated palm sugar is IDR 60,000/kg and liquid palm sugar is IDR 30,000/kg. The output value of granulated palm sugar is IDR 7,800 and liquid palm sugar is IDR 3,600. The output value in the processing of palm sap into granulated palm sugar and liquid palm sugar is obtained from the multiplication of the conversion factor by the output price. The added value in the processing of palm sap into granulated palm sugar is IDR 4,800/kg and liquid palm sugar is IDR 600/kg. The amount of added value of granulated palm sugar is obtained by subtracting the output value of IDR 7,800/kg from the raw material cost of IDR 3,000/l. Meanwhile, the amount of added value of liquid palm sugar is obtained by subtracting the output value of IDR 3,600/kg from the raw material cost of IDR 3,000/l.

Income from granulated palm sugar and liquid palm sugar

Income analysis shows the financial position of a business. Income analysis consists of two components, namely revenue and expenditure (Yelfiarita et al. 2022). Revenue is the product of the amount of production obtained and the number of units sold (Faliha et al. 2022). Meanwhile, expenditure is the cost incurred during the production process, including fixed costs and variable costs (Yelfiarita et al. 2022). To analyse income, it is necessary to inventory the costs required during the production process and calculating business revenue. The cost

parameters calculated include equipment costs, material costs, and labor costs. Table 3 shows a comparison of income between granulated palm sugar and liquid palm sugar.

Table 3 shows that the costs and income from granulated palm sugar are higher than those from liquid palm sugar. Monthly production is 181 kg for granulated palm sugar and 36 kg for liquid palm sugar, reflecting differences in the number of production days per month (22 days for granulated sugar vs. 12 days for liquid sugar). Total monthly income is IDR 9,782,083 for granulated palm sugar and IDR 202,917 for liquid palm sugar. On a per-kilogram basis, income is approximately IDR 54,062/kg for granulated sugar and IDR 5,636/kg for liquid sugar, indicating a substantially higher value added and profitability for granulated palm sugar.

Table 2. Results of added value calculations for granulated palm sugar and liquid palm sugar using the Hayami method

Variable	Result	
	Granulated palm sugar	Liquid palm sugar
Output, input and price		
Output (kg)	97	35
Raw Material (litres)	725	270
Labour (HOK)	12	12
Conversion Factor	0.13	0.12
Labour Coefficient (HOK/kg)	0.01	0.04
Output Price (IDR/kg)	60,000	30,000
Revenue and Profit		
Labour Wages (IDR/HOK)	5,000	5,000
Raw Material Price (IDR/l)	3,000	3,000
Output Value (IDR)	7,800	3,600
a. Added Value (IDR/kg)	4,800	600
b. Added Value Ratio (%)	61	16
a. Labour Income (IDR/kg)	50	200
b. Labour Share (%)	10	33
a. Profit (IDR/kg)	4,750	400
b. Profit Margin (%)	98	66
Remuneration for Production Factors		
Margin (IDR/kg)	4,800	600

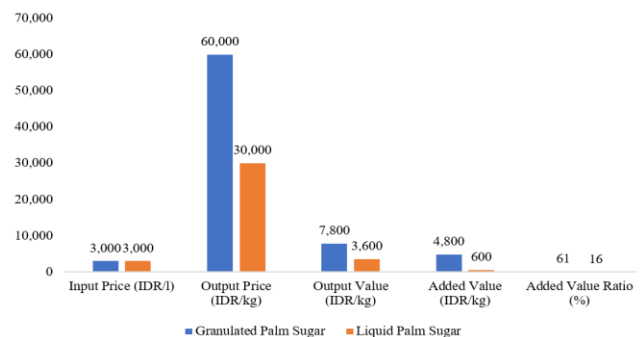


Figure 2. Input, output, and added value analysis of granulated palm sugar and liquid palm sugar

Discussion

Palm sap processing at FFG Buhung Lali

The potential for developing palm sugar in South Sulawesi is quite promising, considering the agroecological and conservation aspects as well as its usefulness. Palm trees can grow at an altitude of 0-1.400 metres above sea level, in places along rivers, valleys and forests. This plant generally grows wild, but in some areas it is cultivated for economic and conservation purposes. The main products of palm trees are sap, fibre, flour, leaves and stems, which can be further processed continue to have high economic value. This plant can also be developed as a conservation plant due to its deep root system and strong grip on the soil (Hidayat and Soimin 2021).

Research in Bukit Harapan Village found that each respondent had 1-5 palm trees ready for tapping, with a tapping period of 10-15 years. At the research site, each palm tree could produce 5-20 litres of sap per day with tapping carried out twice a day, in the morning and afternoon. Palm sap production is used as a source of livelihood, particularly for palm sugar products. The stages of processing palm sap into palm sugar and liquid palm sugar include tapping, cooking, packaging, and sales.

The method of tapping, collecting, and processing palm sap affects the quality and sugar content (Awalia and Faza 2025). Palm farmers tap the palms themselves without using labour, but the process of converting palm sap into sugar requires labour that needs to be paid. Sap tapping is carried out by FFG members who have the necessary skills, as sap tapping requires technical expertise that is possessed by every tapper. Tapping is carried out twice a day, in the morning from 07:00 am to 08:00 pm and in the afternoon from 04:00 am to 05:00 pm. Sugarcane tapping begins with preparing the equipment to be used. Once all the equipment is ready, tapping begins by cleaning the sugarcane stalks of their husks. Farmers then beat the sugarcane stalks using a wooden mallet made of ironwood, which is done once a day, repeatedly, 20-50 times slowly for approximately 20 minutes. One palm tree can be tapped for 2-3 male flowers if it shows signs of being ready for tapping. One bunch of male flowers with high water quality can produce palm sap for 2-3 months. This is in line with the results of a study (Kusrini et al. 2023) which states that each palm tree can be tapped 3-4 times per year and each stalk can be tapped for 2-3 months or even longer depending on several factors, mainly the growing environment and the type of palm.

The amount of sap that can be tapped by tappers varies depending on the availability of male flower clusters. Based on interviews with respondents who carry out tapping, a tapper can tap one male flower cluster per tree per day, with 4-5 trees per day (morning and afternoon). The production of granulated palm sugar and liquid palm sugar is generally similar, except that the process of making granulated palm sugar takes longer than liquid palm sugar. In the production of liquid palm sugar, the sap is cooked until it thickens, then removed and cooled. At

this stage, the liquid palm sugar is ready to be packaged and marketed. Meanwhile, to make granulated palm sugar, the sap is boiled until it clumps together, then stirred and cooled. To test whether the sap is ready to be crushed, a small amount of the sap that is being boiled is dissolved in clean cold water. If the sap water freezes, the sugar is ready to be cooled for the crushing process. Once cooled and hardened, it is ground until it becomes a fine powder. The powder is then sifted to separate the fine sugar from the coarse sugar, and this process is repeated until all the sugar has been sifted. Next, the sugar is dried by sun-baking to remove the moisture content until the granulated palm sugar is ready to be packaged and marketed.

Figure 3 shows the process of tapping and collecting sap from palm sap. In the left image, a worker taps the tree by climbing it to collect the sap. In the right image, the sap is collected in containers before being processed into products such as palm sugar. This activity has economic value and requires specialised skills.

Figure 4 shows the process of processing palm sap into granulated palm sugar and liquid palm sugar. The process begins with boiling the sap over a stove until it thickens. Afterwards, the products are packaged in various forms, such as granulated palm sugar in pouch and liquid palm sugar in bottles. This process aims to increase the product's market value and extend its shelf life.

Table 3. Revenue from granulated palm sugar and liquid palm sugar during one month of production

Component	Granulated palm sugar	Liquid palm sugar
Monthly Production (kg;l)	181	36
Selling Price (IDR/kg; IDR/l)	60,000	30,000
Fixed Costs/Equipment (IDR/Month)	730,417	634,583
Depreciation Cost (IDR/Month)	190,694	143,819
Variable Costs (IDR/Month)	347,500	252,500
Total Cost (IDR/Month)	1,077,917	887,083
Revenue (IDR/Month)	10,860,000	1,080,000
Income (IDR/Month)	9,782,083	202,917
R/C Ratio (IDR/Month)	10.07	1.21



Figure 3. The process of tapping and collecting palm sap



Figure 4. The process of cooking and packaging granulated palm sugar and liquid palm sugar

Added value of granulated palm sugar and liquid palm sugar

This study shows that the production of granulated palm sugar generates significantly higher added value and economic profit compared to liquid palm sugar. The added value of granulated palm sugar is IDR 4,800/kg with an added value ratio of 61%, whereas liquid palm sugar only yields IDR 600/kg with a 16% ratio. Profits from granulated palm sugar are also higher, with a profit rate of 98% compared to 66% for liquid palm sugar. These findings are consistent with previous research by Purbaningsih et al. (2022), which reported that granulated sugar products have higher economic value than other sap-based products, primarily due to the more complex processing that generates significant added value. Similarly, Burhanudin et al. (2025) found that palm sugar agroindustries producing solid products, such as granulated sugar, achieved greater profitability and operational efficiency compared to liquid products. This is also supported by Akhri et al. (2025), who demonstrated that product diversification with high added value contributes to increased income for farmers and small-scale entrepreneurs in the sugar agroindustry. In all cases, the sign of value added (> 0) confirms that processing generates additional value for both products (Hayami et al. 1987; Ramadhani et al. 2022).

However, these differences in added value should also be viewed in the context of market structure and production scale constraints at the farm level. Palm sugar production at the small-scale producer level is generally still affected by limited output volume, price fluctuations, and unstable market access. These conditions may prevent some producers from fully capturing the potential value added generated at the processing stage, particularly when bargaining power remains weak and market access is limited.

In this context, increasing value added does not depend solely on the production process, but also on the ability of producers to improve efficiency, maintain product quality, and expand market access. The labor analysis shows that although liquid palm sugar has a higher labor cost contribution to total production costs, its economic efficiency remains lower than that of granulated palm

sugar. This indicates that higher labor intensity does not necessarily translate into higher economic value, especially when it is not accompanied by higher selling prices.

Compared with Hayami-based studies in similar MSME contexts, for example, ground coffee processing in Indonesia that often reports value-added ratios above 40%, our estimates indicate a potential cost-price squeeze at the producer/processor node, likely linked to thin markets and uneven access to quality-sensitive buyers (Rizaldi et al. 2023; Lestari et al. 2026). Indonesia's spatial food markets also exhibit slow and incomplete price transmission across provinces, so upstream actors do not fully participate in downstream price rises, particularly where logistics and information are weak (World Bank 2019; Nendissa et al. 2020).

The socio-economic implication is that without upgrading, incomes and reinvestment in hygienic tapping, energy-efficient boiling, and basic quality control remain constrained. Consistent with the upgrading literature for developing-country chains, feasible pathways here include: (i) process upgrading, improving sap hygiene and heat-stabilization to raise conversion yields and consistency; (ii) product upgrading, standardized granulated and liquid sugar that meet buyer specifications; (iii) functional upgrading, group-based grading/packing and simple QA; and (iv) inter-chain upgrading, differentiation via certification or origin-linked products (Humphrey and Schmitz 2002; Trienekens 2011). These measures, when paired with inclusive arrangements such as producer organizations and service-embedded contracts, have been shown to strengthen market access and stabilize smallholder incomes (Vos and Cattaneo 2020).

The magnitude of added value aligns with the added value ratio relative to output value. This ratio is calculated by dividing the added value by the output value, expressed as a percentage (%). There are three indicators for categorizing the added value ratio: $<15\%$ indicates low added value, $15\text{--}40\%$ indicates medium, and $>40\%$ indicates high added value (Fudjaja et al. 2023). According to Istiani and Soetriono (2022), a product is considered to have added value if the added value is greater than 0, while a negative added value indicates no economic gain. The added value ratio for granulated palm sugar is 61%,

whereas for liquid palm sugar it is 16%, indicating that both products provide economic value.

Higher labor income from liquid palm sugar, as observed in this study, indicates that its production is more labor-intensive due to differing processing stages. On average, artisans work about 8 hours per day, starting from sap tapping to sugar production, with cooking times varying between granulated and liquid sugar; granulated sugar requires 4-5 hours per batch, whereas liquid sugar takes 1-2 hours per batch. International studies indicate that the agro-processing sector is typically labor-intensive, with significant working hours affecting labor income and production cost structure (Marchini et al. 2024; Hamidy and Arisoy 2026). Nominal labor income for liquid sugar is higher (IDR 200/kg) compared to granulated sugar (IDR 50/kg), yet the labor cost share of total production is lower for granulated sugar (10%) than for liquid sugar (33%). This suggests that granulated sugar production is more capital-intensive and efficient in labor use.

The added value analysis also reveals the margin from raw sap to granulated and liquid sugar, distributed between direct labor income and farmer profit. This margin is the difference between product value and raw sap price per liter. According to Janah and Adinasa (2024), higher selling prices lead to larger margins. This aligns with the margins observed in this study: each liter of sap processed into granulated sugar yields a margin of IDR 4,800 at a selling price of IDR 60,000/kg, while liquid sugar generates a margin of IDR 600 at IDR 30,000/kg.

This study aligns with global trends in the palm sugar agroindustry, particularly in promoting product diversification and value addition. Furthermore, it provides empirical evidence supporting the development of high-value-added products that can enhance economic sustainability for farmers and small-scale business owners.

In conclusion, granulated palm sugar production generates significantly higher value added and economic benefits compared to liquid palm sugar, with value added reaching IDR 4,800/kg and a ratio of 61%, while liquid palm sugar only reaches IDR 600/kg with a ratio of 16%. In addition, the profit rate of granulated palm sugar at 98% far exceeds that of liquid palm sugar at 66%. Although labor income per kilogram is higher for liquid palm sugar, the proportion of labor costs to total production costs in granulated palm sugar is lower, indicating more efficient labor utilization. These findings suggest that the development of granulated palm sugar agroindustry has greater economic potential and should be a primary focus in efforts to increase the income of farmers and small-scale enterprises based on palm sap. Furthermore, this study highlights the importance of community-level quality control aligned with national standards (SNI), improved producer aggregation and production scheduling, pilot implementation of quality-based pricing, clearer market targeting for liquid and granulated products, prioritization of halal and BPOM certification pathways, and low-cost process improvements to reduce losses due to off-spec products. Nevertheless, optimizing labor use and processing technology remains necessary to support production efficiency and sustainability. Overall, product

diversification and increased value added through granulated palm sugar processing have the potential to significantly enhance community welfare and promote sustainable agroindustrial development, although the descriptive nature of this analysis indicates the need for further research using regression or panel data approaches to measure the responsiveness of value added to variations in capacity, price, and volume, as well as to test resilience under different operational conditions.

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