

Cost and Trend Analysis of Sago Processed Businesses in North Luwu and Palopo City, South Sulawesi Province

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ABSTRACT

This study investigates sago-based food processing businesses' cost structure, profitability, and sustainability trends in North Luwu and Palopo City, South Sulawesi, Indonesia. Despite sago's strategic role as a traditional food and a climate-resilient crop, the industry faces declining raw material availability, low farmer income, and limited technological adoption. Using a combined qualitative-quantitative descriptive approach, including structured surveys and focus group discussions (FGDs), this research provides a detailed cost and trend analysis of micro and small-scale enterprises producing local sago foods such as bagea, dange, and kapurung. The findings reveal that while these businesses remain economically viable—with R/C ratios above 1.0 and the dange business reaching 2.1—profitability is constrained by small-scale operations, high input costs, and inadequate support systems. This study fills a critical research gap by shifting focus from upstream sago cultivation to downstream enterprise viability, offering a rare empirical insight into the dynamics of traditional food microenterprises in Indonesia. The novelty of this research lies in its integrated assessment of cost efficiency, scale potential, and policy implications. It proposes strategic interventions including modernizing processing technologies, strengthening farmer-producer linkages, and scaling up through cooperative models. The results provide actionable recommendations for local governments and agribusiness stakeholders aiming to revitalize indigenous food sectors. Future research should explore the design of sustainable enterprise clusters, examine consumer preferences for sago-based products, and evaluate the long-term impacts of technological and institutional interventions on sago industry resilience.

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Keywords:

Cost and trend analysis; food security; micro enterprises; sago processing business.

1. Introduction

Sago is a staple food for Indonesians, especially in certain areas, such as South Sulawesi (Sidiq, 2022; Fitriyah, et al., 2025). In this province, the processed food industry and trade using sago starch have grown along with the natural abundance of raw sago materials. The Tana Luwu region (Luwu Regency, North Luwu, East Luwu, and Palopo City) is

the center of sago production in South Sulawesi, contributing significantly to the province's total sago production (Metaragakusuma et al., 2017; Sumantri, 2022; Dewani, et al., 2022). The abundance of sago plants in coastal swamplands and flood-prone areas supports the growth of various sago processing businesses, producing traditional foods such as dange and kapurung that are popular even in Makassar City. For example, kapurung cuisine made from sago is now widely marketed and has led to the establishment of several kapurung specialty restaurants in Makassar (Nuryanti et al., 2019), indicating a high demand for sago-based processed foods.

Globally, sago plants are considered to have strategic potential as an alternative food source amid the threat of a global food crisis. The United Nations (FAO) projects that global food production needs will increase by approximately 60% by 2050, in line with population growth (Konuma, 2018; Ehara et al., 2018). In the face of limited fertile land and climate change, sago stands out as an underutilized food commodity that can be grown on marginal land with high productivity (Yamamoto, 2018). Sago can be cultivated on unused wetlands, such as peat swamps, that are unsuitable for other food crops, and each tree produces high starch yields (150–300 kg of dry flour per trunk) (Ehara et al., 2018). Researchers have highlighted these advantages; Dr. Isao Nagato from Japan even strongly believes that sago can help address the global food crisis of the 21st century (Okazaki & Sasaki, 2018). Sago's adaptive ability to thrive in extreme environments further supports this view. Sago thrives in waterlogged, acidic, or nutrient-poor peatland soils, including riverbanks and swamps, where other food crops struggle to survive (Yamamoto, 2018). Sago's resilience to suboptimal conditions and climate change makes it a reliable carbohydrate source that plays a strategic role in ensuring future human food security (Tjokrokusumo, 2018; Murod, et al 2019; Yusuf et al., 2023).

Ironically, although Indonesia (along with Papua New Guinea) has the largest area of sago land in the world, the area of sago in Indonesia continues to shrink every year due to a lack of interest in cultivation and the underdevelopment of sago agronomy systems (Nur'aini, 2020). Signs of the threat of extinction of this potential food commodity are already apparent in several regions. For example, in Maluku, the sago forest population plummeted from approximately 100,000 ha in the 1960s–1970s to only 58,000 ha in 2016 (Sidiq et al., 2021). Experts believe that if this trend continues without serious intervention, the extinction of sago in the region will only be a matter of time. Other regions face similar challenges; in Paser Regency (East Kalimantan), for example, the traditional sago production and management system is considered unsupportive of optimal growth or the implementation of best management practices (Fatah et al. 2015). South Sulawesi is beginning to show signs of declining sago potential. In the North Luwu District, the main center of production, the expansion of other agricultural lands has reduced the area of sago forests annually. Although South Sulawesi's sago production data for 2021 is still approximately 2,943 tons, long-term trends show a decline in the sago population in the Tana Luwu region over the past decade (Metaragakusuma et al., 2017). The decline in the availability of sago raw materials is feared to have a direct impact on the sustainability of local sago processing businesses, from the sago flour industry to traditional food producers. Manambangtua's (2020) research revealed how low the income of sago farmers in North Luwu is – an average of only ~Rp1.3 million per year – which has triggered a shift in business or a reluctance to regenerate sago farming. This situation threatens the continuity of the sago starch supply

for sago-processing businesses (craftsmen producing dange, kapurung, traditional cakes, and others) in the region.

Based on the above discussion, the research gaps that need to be addressed can be formulated. So far, there have not been many studies that highlight the financial feasibility and long-term sustainability of smallholder sago processing businesses in major production centers. Previous studies have primarily addressed the value chain and marketing strategies for sago (Saruman et al., 2025) or feasibility studies in different contexts (e.g., in Southeast Sulawesi) (Kamaluddin et al., 2022), leaving the sustainability aspects of sago processing businesses in the Tana Luwu region under-examined. However, given the declining availability of sago raw materials and the continued high market demand, a deeper understanding of whether small-to-medium-scale sago-processing businesses are still profitable and capable of sustaining operations is needed. This research enriches the body of knowledge while providing practical information for the development of the local sago agroindustry. This study conducts a cost analysis to measure the cost structure, revenue, and profit margins of sago processing businesses, which serve as indicators of their viability.

Additionally, a trend analysis of business development was conducted to observe the trends in the number or existence of sago processing businesses over time within the community. The cost analysis approach will reveal whether these sago processing businesses are truly profitable and efficient at the household/small-scale industry level, while trend analysis will show whether the number of such businesses is increasing, stable, or declining. The combination of these two analyses provides a comprehensive picture of the health of the local sago processing industry and the factors that influence its sustainability. Thus, this study is expected to fill the literature gap and generate recommendations for future efforts to preserve and develop the sago industry.

2. Materials and Methods

This study was descriptive, qualitative, and quantitative, using *research and development (RD)* and *survey research* techniques. Data were collected using individual and in-depth interviews (independent interviews) through *Focus Group Discussions (FGDs)* for economic business institutions, policymakers, and stakeholders. The respondents were grouped into farmers, traders, sago seed providers, and other facilities for individual interviews. The FGD method was used to obtain comprehensive and complementary data and information so that the actual situation in the field could be described.

- 1) Preparation stage: The initial stage of the activity is the preparation stage, which includes several activities, namely: (1) Team Meeting, intended to prepare the implementation plan and division of tasks in the team; (2) preparation of questionnaires used in research that refer to the research objectives; and (3) Coaching the Research Team, intended to equalize perceptions regarding the direction and objectives of the research, as well as other matters deemed necessary to support the smooth implementation of this study.
- 2) Questionnaire revision stage and preparation of production process materials: The next activity was to revise the questionnaire based on the test results. This revision was an effort to adapt the questionnaire so that the research team could obtain a realistic picture of the field. It was hoped that the adapted questionnaire

would be a more effective, efficient, and good guide for achieving the research objectives. Basic and auxiliary materials were prepared to produce the planned and determined prototypes.

3) Research implementation stage

The research was then implemented using 2 (two) methods: (i) a structured Survey and Focus Group Discussion (FGD) and (ii) according to each research aim. Research and development (R&D) methods are used to produce new product designs, test the effectiveness of existing products, and develop and create new products. The research steps were as follows.

- a. Initial condition assessment survey
 - b. Providing training on cooperative personal capacity building
 - c. Survey for final evaluation
- 4) Data collection and processing. Data collection was conducted by researchers, along with recruited surveyors or enumerators. Data collection began with "coaching" the surveyors/enumerators. This was done to explain the purpose and objectives of the study and to equalize the perceptions of the data to be collected.
- 5) Data tabulation. The Research Team edited the primary data collected to maintain consistency and accuracy of the data collected. Data verified for accuracy were tabulated and categorized using Microsoft Excel by the recruited data entry personnel.
- 6) Data Analysis. The tabulated and grouped data were analyzed using qualitative and quantitative descriptive analyses.
- 7) Data Compilation/Comparison Stage. The next stage involved the compilation and comparison of the analysis results of the two groups. The analysis results were compiled to combine the results from the two approaches, namely, the survey results and Focus Group Discussion (FGD) results. The results of the quantitative study data were combined and compared with the results of the FGDs to complement each other.

3. Results and Discussion

3.1 Economic Viability of Processed Sago Products

The findings indicate that sago-based enterprises in Tana Luwu (covering North Luwu Regency and Palopo City) have promising economic prospects for local entrepreneurs in Tana Luwu. Traditional sago products, such as bageas (a type of sago cookie) and dange (a grilled sago cake), show positive profit margins, reflected in their revenue-to-cost (R/C) ratios. For example, a typical bagea production business in the region yields an average net income of approximately IDR 7,323,885 per month, with an R/C ratio of 1.1. This implies that for every IDR 1 spent, the business returns IDR 1.10 in revenue, a modest but viable profit. The dange production business appears even more efficient, exhibiting an R/C ratio of 2.1, meaning every IDR 1 of cost generates approximately IDR 2.10 in revenue. This high ratio for dange reflects strong operational efficiency and profitability, outpacing other sago-based products in the area. These figures confirm that, at the current scale, sago processing businesses are economically feasible and can generate sustainable income for entrepreneurs.

However, it is evident that business scale and operational efficiency significantly influence profit levels. Many producers in Tana Luwu operate on a micro-or small scale, often using simple technology and limited capital. For instance, the average dange producer in this region relies on minimal capital investments and traditional home-based techniques. In the dange business surveyed, total production costs were approximately IDR 1,141,387 per month, while total revenue reached IDR 2,385,800, yielding a net income of approximately IDR 1,244,413 per month. This shows that even small-scale operations can be profitable because of the low overhead costs and the use of family labor. Nonetheless, the absolute profit level remains relatively low in monetary terms because of its small scale. These results suggest that, while current operations are profitable, expanding the scale of production or improving efficiency could further increase income. The data also underscore that achieving economies of scale, for example, by producing bagea or dange in larger batches or with better equipment, might even improve profit margins and total earnings, which is an important consideration for future business development.

3.2 Nutritional and Strategic Value of Sago

Beyond financial metrics, sago is strategically important as an alternative food source for food security and cultural heritage. Sago starch is naturally gluten-free and very low in fat, appealing to modern consumers who are health-conscious or have dietary restrictions. It is increasingly promoted as a gluten-free, non-allergenic carbohydrate source in broader markets. Although sago is primarily a source of carbohydrates and is not rich in proteins or micronutrients, its low calorie density and the absence of gluten make it an attractive ingredient for developing healthier or specialty food products. In Indonesia and abroad, for example, sago flour is used to make products such as noodles, bread, and desserts as a substitute for wheat, tapping into the growing demand for gluten-free foods.

From a food security perspective, sago has significant potential because it can thrive on suboptimal lands, such as waterlogged soils, swamps, and peatlands, where other staple crops (such as rice or corn) may not grow well. This resilience indicates that sago cultivation can be expanded without competing for prime agricultural land. In Tana Luwu, sago has traditionally been a staple and holds cultural significance, and dishes like kapurung (sago porridge) are integral to local cuisine. By leveraging Sago's ability to grow in marginal environments, there is an opportunity to enhance food security in other regions of Indonesia. Indonesia has millions of hectares of underutilized sago palm stands. If properly managed, they can produce a volume of starch comparable to or exceeding that of some mainstream crops. Thus, sago represents not only a link to cultural identity in Tana Luwu but also a strategic food resource for Indonesia's future – one that is climate-resilient and supportive of dietary diversification.

3.3 Challenges to the Sustainability of the Sago Industry

Despite its potential, the sago processing industry in Tana Luwu faces serious challenges that threaten sustainability. The key challenges identified include the following.

- **Low Farmer Incentives and Declining Cultivation:** At the upstream end, there is a waning interest among farmers in cultivating or harvesting sago. Research data show that the average annual income for sago farmers in North Luwu is only around IDR 1,312,186 (less than US \$ 100). This extremely low return is far below

the income of other commodities, making sago palm cultivation an unattractive livelihood choice. Consequently, the younger generations are less inclined to continue the tradition of sago farming. The decline in the number of active sago farmers has led to decreased sago production in the region. This trend could worsen without intervention, leading to raw material shortages in local sago processors.

- **Traditional Processing Methods and Technological Gaps:** Most sago processing businesses in the area still rely on traditional, labor-intensive methods, which limit productivity and efficiency. The case of bagea production illustrates this issue: a substantial part of bagea's production cost comes from additional ingredients, such as spices and sweeteners (approximately IDR 52,297,500 per month in one survey), rather than the sago itself. Reliance on manual techniques and inefficient use of inputs increase costs. Moreover, small-scale processors often cannot afford modern machinery; therefore, their capacity remains limited. A broader examination of Indonesia's sago sector confirms that technological constraints are a significant challenge for small-scale producers. Due to their high acquisition and operating costs, small and scattered production units struggle to adopt advanced postharvest technologies. In some cases, this is not sustained, even when technology is introduced. For example, in a Papua pilot project, providing motorized equipment led to a temporary spike in production that was not matched by market demand, causing farmers to hold back out of fear of overharvesting their palms. This finding highlights that technology adoption must be appropriate and coupled with market development.
- **Decline of Sago Forests and Land Conversion:** Environmental and land-use changes pose serious threats. Sago lands in Tana Luwu are shrinking as swamps and fields traditionally used for sago are converted to other uses (such as rice fields, plantations of other cash crops, and even residential and industrial purposes). Sago palms often grow wild or semi-wild, and without formal protection, they are easily cleared or sold for short-term gains. Evidence from other regions shows that government policy has prioritized crops such as rice over sago, even in areas well suited to sago. For instance, thousands of hectares of sago forest in Maluku are at risk of being cleared for rice cultivation under national programs. Such land conversion not only reduces the current sago supply but also undermines the ecological conditions needed for the natural regeneration of sago. Because sago palms take approximately 8–10 years to reach maturity, overharvesting or loss of sago stands cannot be compensated quickly. This raises concerns about the future availability of raw materials for Tana Luwu's sago industry.
- **Limited Policy Support and Institutional Strengthening:** There is a notable lack of policy and institutional support to encourage growth in the Sago sector. Unlike major staples (rice and corn) or export commodities (palm oil and cocoa) that enjoy subsidies, research, and extension services, sago has historically received relatively little attention from policymakers. Local producers in Tana Luwu reported the absence of government incentives, such as subsidies for sago

cultivation, price support, or technical assistance programs. Additionally, the organization of farmers and processors remains weak, with few cooperatives or formal groups to help with marketing or resource sharing. This institutional gap means that sago entrepreneurs largely fend for themselves, making it difficult to tackle the abovementioned challenges.

These challenges are interrelated: low profitability for farmers discourages cultivation, which reduces the raw material supply; traditional methods maintain low productivity and high costs, perpetuating low incomes; and without policy support, there is little impetus to invest in better technology or other means to conserve sago-growing areas. If not addressed, these issues could lead to a vicious cycle of declining production and shrinking the significance of sago in the local economy. This situation calls for interventions to break the cycle and ensure that the sago processing business can not only survive but also expand sustainably.

3.4 Strategies for Sustainability and Scaling-Up

A comprehensive strategy is needed to safeguard the future of processed sago in Tana Luwu and to enhance its contribution to the local economy. This strategy should focus on improving productivity, increasing efficiency, and facilitating growth, while considering sustainable business expansion. The key recommendations are as follows.

- **Enhancing productivity through agricultural improvements:** boosting sago palm productivity is fundamental. This can be achieved by developing and planting superior sago varieties with higher starch yields and shorter maturation periods. Agricultural research institutions and universities should focus on the selective breeding and tissue culture propagation of high-yield sago palms. Farmers would benefit from training in modern cultivation techniques, for example, managed planting of sago suckers (shoots), instead of relying solely on wild stands. Farmers in regions such as Riau actively cultivate and propagate sago palms, which have helped ensure a steady supply to large mills. Similar practices in Tana Luwu (such as scheduled planting, palm maintenance, and controlled harvesting cycles) could increase raw material availability. Better farm management, including fertilization of palms and pest control, when necessary, can also improve yields. Increasing farm-level productivity and raw material supply will make it feasible to scale up processing activities without depleting the natural sago stands.
- **Technological Upgrading and Process Efficiency:** Introducing sophisticated processing technologies can significantly improve operational efficiency, product quality and cost-effectiveness. Given that current operations use very simple tools (e.g., handmade ovens, manual graters, and simple presses), even modest upgrades could have a significant impact. For instance, mechanized rasps and presses can extract starch from sago logs faster and more thoroughly than manual methods, yielding more starch per log than manual methods. Research has shown that using technologies such as a micro powder mill to process sago pith can increase starch extraction by approximately 17%, thereby reducing the processing time. Similarly, improved drying equipment or ovens could accelerate bagea and dange production and ensure a consistent quality. The fixed

costs of the surveyed bagea business were very low (approximately IDR 488,615 per month for tool depreciation), suggesting that the machinery used was rudimentary. Investing in better equipment through government grants, cooperative buying, or micro-credit for small businesses allows producers to scale up their production and reduce per-unit costs. Any technology introduced must be appropriate for the local context: machines should be durable, easily maintained locally, and sized to the scale of the available raw material. In addition to hardware, improved process management (such as better mixing ratios to reduce wasted ingredients or improved packaging techniques to extend shelf life) can increase efficiency. For example, vacuum-sealing sago starch or using proper packaging for bagea could increase product shelf life and widen market reach without incurring additional costs. Overall, the modernization of the processing stage will enable sago businesses to handle larger volumes and improve their profit margins.

- **Scaling Business and Market Expansion:** Although current sago enterprises in Tana Luwu are small-scale, there is potential to scale up these businesses in a way that benefits the community. One way is to form cooperatives or clusters of producers. Sago entrepreneurs can achieve economies of scale by purchasing raw materials, sharing equipment, and marketing products by pooling their resources. This model has seen success elsewhere: for example, in Riau (a region on Sumatra), a cooperative called Koperasi Harmonis groups small sago mills to ship collectively and market dried sago starch to Java. Such collective action has helped Riau become the largest domestic supplier of sago starch, far surpassing the output from Sulawesi. Tana Luwu's producers could emulate this by coordinating their production and seeking larger distribution channels. Scaling up also means looking beyond local markets: broader market development is needed to absorb increased production. There is a growing demand for sago products regionally and internationally; for instance, sago starch and roasted sago from Indonesia are sold to Java, Malaysia, and Japan for use in food and desserts. If producers in Tana Luwu can meet higher-quality standards, they can tap into larger markets. Product diversification and innovation also aid market expansion. In addition to traditional products such as bagea and kapurung, entrepreneurs may develop new sago-based snacks, gluten-free flours, or instant meal products that cater to modern tastes. The sago industry can increase its economic impact by scaling up cautiously and strategically. However, it is important to note that rapid industrial-scale expansion should be balanced with sustainable sourcing. A study of sago industries in Maluku found that fully modernized large factories, while highly productive and profitable, faced problems of raw material shortages and unsustainable harvesting rates. This suggests that a gradual scaling approach, in which production volume is increased in steps with replanting efforts and market growth, is preferable for long-term stability. This means targeting a medium-scale, intensive-but-sustainable business model, rather than immediately building large mills that could overexploit local sago forests. The goal for Tana Luwu should be to grow the sago sector in a resilient way by scaling up business capacity and market

reach, while simultaneously ensuring that sago cultivation and supply can support growth for years to come.

- Addressing farmers' livelihoods and raw material supply: Any effort to expand processed sago businesses must directly involve and incentivize farmers who supply sago starch. To overcome the low income of sago farmers, the value chain needs to be adjusted so that farmers receive a better share of the end-product value. One suggestion is to introduce the smallest price guarantees or premium pricing for sago logs that meet certain quality standards, thus providing farmers with an immediate reward for cultivating sago. Another approach is to process enterprises (or cooperatives) to support farmers through profit-sharing or outgrower schemes. For example, processors can provide seedlings or financial support for planting, in exchange for future supply contracts with farmers. In North Luwu, where farmers currently see little reward, such models could rekindle interest in sago as a viable crop. Diversifying farmer income from sago is also worth exploring: sago palms produce by-products, such as sago larvae (edible grubs) and sago fronds (for weaving or compost) that can be sold, and integrating livestock (such as free-range ducks or fish in sago groves) could provide additional income while sago palms mature. Ultimately, improving farmers' livelihoods will ensure a stable supply base for processors and help to maintain sago cultivation.
- Policy Support and Institutional Development: Greater government support is critical for overcoming the challenges faced by the sago industry. At the policy level, recognizing sago as a strategic food commodity (as some Indonesian officials have started to do) should translate into concrete local programs. Subsidies or financial incentives can be provided to establish sago nurseries, purchase processing equipment, or certify sago products for food safety. Extension services and technical training should be offered to both the farmers and processors. For instance, agricultural officers can teach best practices in sago cultivation, while industry facilitators can train small businesses in packaging, marketing, and quality control. Local governments can also play a role in land use planning by protecting existing sago-growing wetlands from conversion and possibly appointing certain areas as "sago reserves" or agroforestry zones; they can secure the raw material base for sago production. In regions such as Meranti (Riau) and Papua, where sago is important, local governments have begun implementing sago development policies, including conservation and community training. The provincial authorities of South Sulawesi and the local governments of Tana Luwu could adopt similar measures. Additionally, legal and financial support from the government should facilitate the formation and strengthening of sago farmer/producer cooperatives. Such institutions can improve bargaining power, streamline supply chains, and improve the interface with government programmers. If local stakeholders organize, they can lobby for their interests – for example, requesting infrastructure improvements, such as access to roads to sago-growing villages or electricity for processing centers. Public-private partnerships might also be explored, where government agencies partner with private investors or NGOs to pilot modern sago harvesting and

processing centers, ensuring technology and knowledge transfer to local communities.

- **Promotion and Market Education:** Finally, a concerted effort in promotion and consumer education will help expand the market for sago products, which, in turn, will support business scale-up. Although common in Tana Luwu, sago-based foods need to gain popularity in Indonesian society and beyond. Marketing campaigns highlighting Sago's health benefits (e.g., gluten-free, hypoallergenic, and low-fat) and cultural heritage can create new demands. Participation in food expos, inclusion of sago dishes in tourism attractions, and collaboration with chefs to create modern sago recipes could raise the profile of sago. By stimulating demand, these efforts ensure that any increase in production will be met with ready markets, thereby making the entire value chain, from farm to table, more robust.

In summary, the discussion of the results clearly shows that processed sago businesses in Tana Luwu are economically viable at present and closely tied to the region's cultural fabric. A comparison with the existing literature and cases (such as Riau, Papua, and Maluku) reinforces the argument that sago can become a more prominent and sustainable industry with the right support. To achieve this, broader implications, such as scaling the business, must be considered alongside local realities. Suppose that Tana Luwu's sago sector can overcome the challenges of farmer disinterest, technological limitations, and lack of support. In this case, it has the potential to continue as a cottage industry and grow into a significant contributor to regional food security and economic development. By implementing the strategies above – increasing productivity, upgrading technology, scaling carefully, empowering farmers, and securing policy backing – the sago processing industry in Tana Luwu can thrive, and perhaps serve as a model for other sago-producing regions in Indonesia. This holistic approach will help ensure that the rich tradition of sago use does not wane but evolves into a competitive and sustainable agro-industry.

4. Conclusion

This study confirms that sago processing businesses in the North Luwu District and Palopo City are economically feasible and have strategic value for Indonesia's local economic development and food security. Processed sago products, such as bagea, dange, and kapurung, demonstrate positive financial performance, with R/C ratios exceeding 1.0, particularly the dange business, which reaches an R/C ratio of 2.1, indicating strong resource use efficiency and profit potential.

This study's cost and trend analysis contributes significantly to the limited body of empirical research on traditional food-based micro-enterprises in Eastern Indonesia. It offers an evidence-based understanding of sago businesses' operational viability, cost structures, and profitability metrics, and provides valuable insights for both academic discourse and policymaking.

These findings highlight the critical bottlenecks that must be addressed to ensure the long-term sustainability of the industry. These include declining farmer interest, low farm-level income, continued use of traditional technologies, high input costs (as seen in

bagea production), and converting sago-growing land to other trafficking uses. Simultaneously, the increasing consumer demand driven by health-conscious markets offers a clear opportunity for business expansion, innovation, and value chain strengthening.

This study advocates for targeted interventions, including productivity enhancement through superior sago varieties, investment in appropriate processing technologies, farmer incentives, and institutional support in the form of cooperative and policy protection. These measures are essential for transforming the sago industry into a scalable and sustainable rural enterprise model in Indonesia.

Future research should focus on three key areas: (1) developing models for scalable sago enterprise clusters that balance modernization with local resource sustainability, (2) assessing consumer behavior and market acceptance of diversified sago products in national and international markets, and (3) evaluating the long-term impact of policy and technological interventions on sago farmer welfare and environmental conservation. Addressing these gaps will further advance the field and support the broader revitalization of the indigenous food industry in Indonesia and the Global South.

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