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Sago development strategy as a food security commodity in Indonesia

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ABSTRACT

Background: Food estate in Indonesia is currently a hot topic of discussion. This is inseparable from the national strategic food estate project that President Prabowo Subianto has prioritized in recent years. The current food estate project still focuses on non-natural commodities, such as cassava and mornings, which require large resources and land. Indonesia as a tropical country has abundant potential for sago plants as a natural food source, so it does not require massive land expansion. Sago can be a major commodity in food security in Indonesia. **Methods**: This report uses the content analysis method of 6 journal articles and several regulations related to sago management in Indonesia. **Findings:** The results of the analysis are then linked to identify gaps and formulate policy recommendations. Problems that hinder the development of sago as a food commodity currently include a lack of public knowledge, an unoptimized sago supply chain, and deforestation of sago areas due to development. Lack of community knowledge is an obstacle in the development of plantation innovation, the supply chain is not yet optimal, causing complexity in the production and distribution sectors, and deforestation results in the reduction of sago natural land. **Conclusion**: The management and development of sago is currently stated in several regulations, one of which is the Regulation of the Minister of Agriculture Number 134/Permentan/OT.140/12/2013 on Good Sago Cultivation Guidelines. However, some of these regulations still cannot solve the problems that occur. Recommendations that can be delivered on the condition of sago development in Indonesia focus on national government policies so that sago can become a major food commodity for people in Indonesia. **Novelty/Originality of this article:** The novelty of this research lies in the critical content analysis approach that synthesizes various academic sources and regulatory frameworks to evaluate the untapped potential of sago as a national food security commodity in Indonesia.

KEYWORDS: sustainable; food estate; Indonesia; policy; sago

1. Introduction

Provide Food barns, designed in an effort to improve food security in Indonesia, are currently a priority for the government. The current pattern of food barn development in Indonesia still focuses on commodities that are the main needs of the community, including rice, cassava and corn. In addition, the government also focuses on developing sugarcane plantations as a source of raw material for sugar and can be utilized as bioenergy (biofuel). The problem that arises in the development of food barns is the increasing rate of deforestation due to the massive conversion of forest land into plantations. The impact of high deforestation rates is ecosystem instability, reduced biodiversity, and increased potential for climate change.

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Food security in Indonesia is currently still highly dependent on food commodities that have a large impact on the environment. One such commodity is rice produced from rice plants. Virtual water or the amount of water use required in rice is relatively higher than the water needs of other crop commodities. Food barns that depend on rice can have an impact on increasing water demand in the future. The Government of Indonesia should reconsider its policy in developing food security based on rice commodities. One commodity that can be developed as a food barn is sago (Arif, 2023).

The sago plant is one of the plants found in tropical environments. Indonesia as a tropical country has 1,400,000 hectares of sago land, Papua being the area that has the most extensive sago land in Indonesia. Sago diversity in Indonesia is also the highest compared to other countries with 17 plant varieties spread across the island of Papua. Food productivity in 1 sago tree can be processed as much as 50% - 60% into sago flour which can be useful as a food source. Sago flour as a carbohydrate source has a higher caloric value than rice, so that the consumption of 100 grams of sago produces more energy than rice consumption (Arif, 2023).

Indonesia has a relatively large potential for sago plant development with less cost. The ability of sago plants to grow in Indonesia's fresh waters can be an added value because there is no need to add new land as a location for sago plantation development. Sago plants can be an alternative food barn developed by the Government of Indonesia (Arif, 2023). Therefore, there is a need for a strategy to develop sago as a food commodity in Indonesia in a sustainable manner so that people's food needs can be met.

2. Methods

The author uses methods to answer the existing research problem. This section describes the overall research methods used in the research process. Provide sufficient detailed methods to allow the work to be reproduced. Methods already published should be indicated by a reference; only relevant modifications should be described. Author should include the reason behind the decision of location and time of the research. It should be in line with the ontological and epistemological aspects of the research. For the research location, the author may add a map of the research area as long as it follows the cartographical standard. Using a map from a third party should be avoided.

The method must be clear with description of the materials used in the study, the population and sample or key informant, research variables, data sources, the general procedures and techniques, the data collection technique, the analysis method, and data presentation. For research using experiments, the method should also include the design or the setup of the research. For article review, the author should also describe the theoretical components. For a qualitative method, the author may include the methods in data condensation (for example, coding system), data display (how the data is presented which allow for drawing conclusion), and conclusion drawing. For quantitative methods, the author may include the methods in sampling, data collection, and data analysis.

3. Results and Discussion

3.1 Outcome approach

The report on the development strategy of sago as a food source in Indonesia uses a content analysis approach of research journal articles. The method used is content analysis by selecting a total of 6 (six) research articles related to bioenergy in Indonesia within the last 5 (five) years. Each article was then analyzed and described including research results, conclusions, and the current condition of sago commodity development in Indonesia. The results of the content analysis are in Table 1.

Table 1. Number of receptors in each container

Journal Article	Research Results	Conclusion	Current Condition
Advancing Sustainable Agriculture: A Comprehensive Review for Optimizing Food Production and Environmental Conservation (Salkanth et al., 2023)	Sustainable agriculture can improve the optimization of food production and environmental conservation. It has a positive impact on a country's food security.	Technology development plays an important role in sustainable agriculture that collaborates with traditional methods. with traditional methods.	Agroecology can be utilized in the development of sago as a sustainable food commodity sustainable food commodity because positive impact on environmental quality
Sustainability performance assessment of sago industry supply chain using a multi- criteria adaptive fuzzy inference model (Yusmiati et al., 2023)	The sustainability score of sago supply chain performance at the industrial scale is 44.25. The value of the supply chain at the small and medium commodity scale is 48.81.	Condition assessment results sago supply chain in Indonesia is still relatively low. Key indicators that play a role	The condition of supply chain in Indonesia is stil low. Improvement is needed in the recycling sector, profit sharing profit sharing, and waste management.
A Pareto Multi-Objective Optimization for Sustainable Expansion in Sago Plantations (Rajakal et al., 2021)	Sustainable expansion of mangroves would cost USD 155 million. Emissions generated in expansion mangrove land reaches 425 t CO2-eq/ha/y.	Sago land expansion is costly that relatively large with high carbon emissions.	Balancing between expan sion costs and carbon emissions that generated should be balanced in sustainable development.
A Life Cycle Assessment (LCA) Approach on the Production of Sago Sucker for Cultivation (Sulaiman et al., 2021)	Water is the main source of needs in cultivation power and sago development. Environmental quality and market demand for sago can be improved if key growth needs are met.	The main requirements in the development of sago cultivation are water and fossil fuels. Alternatives in replacing both resources can reduce environmental impacts and increase sago productivity.	Optimization of sago plantations sago plantations through increased knowledge, conservation efforts, reduced emissions, and water management can improve the sustainability of water resources and reduce environmental impacts in sago cultivation.
Sago as an environmentally sustainable food resource in the climate change era (Wulan, 2018)	Based on LCA assessment, sago plants can be categorized as a sustainable commodity in peatland ecosystems.	The sago plant has a high value in sustainability indicators, making its development potentially beneficial for the environment.	Sago plantations can reduce the impact of environmental degradation, lower carbon emissions, prevent excessive land conversion, and help maintain soil quality. Overall, sago has a positive impact on the sustainability of peatland ecosystems.

Sustainable management of sago (Metroxylon spp.) agroindustry in Eastern Indonesia has been discussed by Nurlette et al. (2021).	There are 7 variables that influence the management of sago agro-industry in Eastern Indonesia. Variables which are influential are market needs, stakeholder participation, government policy, supportive infrastructure, public satisfaction, farmer resources, and economic activity. The strategies developed in this study include increasing the role of government policy, as well as welfare improvement and the economy of the community.	Sustainable management of the sago industry requires the integration of market needs with active stakeholder participation. In addition, both national and regional policies play a crucial role in enhancing the potential for successful and sustainable sago industry management.	Plantation optimization and management of the sago industry require the role of the government in fulfilling supporting infrastructure, community welfare, and economic stability so that it can reduce the impact on the environment.

Table 1 presents the development of sustainable sago management in Indonesia based on several studies in the last 5 years. Based on the research results, it can be analyzed and concluded regarding the problems and current conditions of sago development as a food security commodity in Indonesia: uneven public knowledge about agroecological methods in sago plant cultivation (Rajakal et al., 2021; Salkanth et al., 2023). The sago processing supply chain in Indonesia is still not optimal due to the lack of policy support and adequate facilities by the government (Nurlette et al., 2021; Sulaiman et al., 2021; Yusmiati et al., 2023). The need for land for sago plants is getting higher because the availability of land on the water's edge is starting to decrease due to use as settlements (Wulan, 2018; Nurlette et al., 2021; Sulaiman et al., 2021).

The agroecological method is an agricultural method that considers the condition and quality of the ecosystem in its management (Salkanth et al., 2023). This method is one of the solutions in sustainable agricultural management because it takes into account environmental conditions and does not only focus on the agricultural sector. Agroecology is one of the solutions in the development of sago cultivation in Indonesia (Rajakal et al., 2021; Salkanth et al., 2023). The sago plant is a type of plant that lives naturally in Indonesia so that the development of sago plantations can adapt to the conditions of its natural environment. The agroecology method is one of the relevant methods developed in Indonesia. Indonesia, but public knowledge regarding these methods is still low (Salkanth et al., 2023). Increasing community knowledge about agroecology in sago cultivation can be a solution in developing sago as a food commodity (Rajakal et al., 2021). The community can more easily understand the environmental conditions that are suitable as sago planting sites. Therefore, through increased agroecological knowledge, the community can take more initiative in developing sago land by taking into account the conditions of the surrounding ecosystem.

The sago supply chain in Indonesia based on Life Cycle Assessment (LCA) based research includes processes in the plantation, distribution, processing and consumption sectors (Nurlette et al., 2021; Sulaiman et al., 2021; Yusmiati et al., 2023). Each sector has

its own role, but the obstacles faced in each supply chain are relatively uniform, namely the supply chain process is not yet optimal. The main factor influencing the lack of optimization of the supply chain in sago management is the lack of support from the government. Policies formulated by the government can provide support in the sago management process in each sector (Nurlette et al., 2021).

Government policies in facilitating licenses and providing subsidies can increase production capacity at the community level. Improving the condition of public facilities by the government can also increase sago productivity through the effectiveness of production distribution. Government policy in limiting the volume of imports of basic needs such as rice and gandung can increase the diversity of food types in the community. Increased food diversity can increase the potential for absorption of sago products as a staple food for the community (Nurlette et al., 2021; Sulaiman et al., 2021; Yusmiati et al., 2023). Therefore, the role of the government in determining policies is very influential on efforts to develop sago as food security in Indonesia.

The sago plant has a natural distribution in tropical environments, generally found in environments directly adjacent to water bodies. The Indonesian Government's food barn project as an effort to improve food security can have a negative impact on the existence of sago land, especially in Papua (Wulan, 2018). The problem faced by sago land is the increase in land conversion into residential locations and government development projects. Development carried out on land peat or land that is a habitat for sago can reduce the land area and the number of natural sago populations (Wulan, 2018; Nurlette et al., 2021; Sulaiman et al., 2021). The reduction in sago land area can hinder the development of sago as a food commodity in Indonesia. Therefore, strategic planning is needed again by the government in developing food security with lower environmental damage.

This report presents the Government of Indonesia's regulations and policies regarding sago development in Indonesia. In general, regulations regarding food security in Indonesia are listed in Government Regulation (PP) Number 17 of 2015 Article 1 Paragraph 15 concerning Food Security and Nutrition. The development of sago as a food commodity is also written in the Regulation of the Minister of Agriculture (MOA) of the Republic of Indonesia Number 134/Permentan/OT.140/12/2013 1/11 on good sago cultivation guidelines. Several provinces that have sago land have also developed guidelines for sago management in their regions. Regulations and policies regarding the development of sago as a food commodity are listed in Table 2.

Current Regulations	Rule Description
Maluku Province Regional Regulation Number 10 of 2011 concerning Sago Management and Preservation	The regulation is a legal umbrella created specifically to regulate the management and conservation of sago plants in Maluku Province. Sago, which is an important commodity for the people of Maluku, is not only the main source of food, but also has an important role in the economy and environment. This regulation is a concrete effort from the Maluku Provincial Government to provide legal protection for the sago plant and ensure its optimal and sustainable utilization. Purpose of the regulation: - Maintain the survival of the sago plant and its ecosystem so that it can continue to be utilized by future generations. - Developing the potential of sago as a commodity with high economic value through various processed products. - Ensure the availability of sago-based food to meet the needs of the Maluku people.
Regulation of the Minister of AgricultureNumber 134/Permentan/OT.140/12/2013 about Guidelines for Good Sago Cultivation	This regulation is a regulation issued by the Ministry of Agriculture of the Republic of Indonesia to provide clear and comprehensive guidelines regarding the cultivation of sago plants. The main objective of this regulation is to increase the productivity and quality of sago production in Indonesia, as well as to preserve the sago plant as an important food commodity.

	With this regulation, it is expected that sago production can be increased, product quality can be guaranteed, and farmers' welfare can be improved. Regulatory objectives: - Provide clear and uniform standards in sago cultivation so that production quality can be guaranteed. - Sago production can be increased both quantitatively and qualitatively. - The aspect of preserving sago genetic resources so that superior varieties are maintained. - The development of the sago industry becomes more focused and sustainable.
Jayapura District Regional Regulation No. 3/2000 on the Preservation of Sago Forest Area	This Regional Regulation is a local level regulation created specifically for Jayapura Regency with the main objective of protecting and preserving the sago forest area in the region. Sago, as we know, is an important commodity for the people of Papua, both as a food source and industrial raw material. With this regulation, it is hoped that sago forests can remain sustainable and provide benefits for current and future generations. Regulatory objectives: - Sago forests are not only a source of food, but also a habitat for various types of flora and fauna. - This regulation aims to preserve the sago forest ecosystem. - Maintain food availability for the local community. - Supporting sustainable development principles at the Provincial level. - More targeted and equitable management of public awareness of sago conservation.

In each of the regulations listed in Table 2, it is known that the management and development of sago cultivation in Indonesia currently considers economic, social and environmental aspects in the community. Sago development has also been carried out more specifically in several regions, so that its implementation will also be more effective optimal. However, the current condition of sago management is still not runing in accordance with established regulations so that there are still problems related to knowledge, supply chains, and land availability. Table 3 explains the relationship between the problems of developing sago as a food commodity and the policies currently implemented, as well as solutions or policy recommendations that can be made by the Government of Indonesia

Bioenergy Issues	Current Policy Condition	Solution/Policy Recommendation
Uneven public knowledge about method groecology in sago cultivation.	None of the regulations listed in Table 1 regulate agroecological methods. Problems that have been regulated in some of these regulations regarding community understanding of sago land preservation. Regulations related to the preservation of sago land still do not explain about the importance of maintaining the condition of the ecosystems around the land, so that can minimize the potential damage to the environment due to sago land.	The Government of Indonesia can establish policy on sustainable sago land management which include ecosystem protection around the sago land area. The regulation can be set on a national scale, so that regions that have sago land can follow and develop based on the regulations that have been set. The gap that occurs regarding current regulations is that the regulations are still local in several provinces, so they are not comprehensive nationally. National scale regulations can have an impact on environmental-

		based sago management ecosystem (agroecology).
The sago processing supply chain in Indonesia is still not optimal due to the lack of policy support and adequate facilities by the government.	Policy the government through the Regional Regulation of Maluku Province Number 10 of 2011 on Sago Management and Preservation has discussed the importance of supply chain management in the production and preservation sectors. The importance of supply chain management in the production sector and distribution. Policies related to the supply chain have been discussed in the regulation, so that they can support sago management. However, there is still a need for efforts to improve adequate facilities by the government in supporting the sago supply chain in Indonesia.	Food agencies or institutions established by the Government of Indonesia can re-evaluate the condition of sago supply chain support facilities in Indonesia. The results of the evaluation can then be developed into development planning in each region that has sago production, so that sago processing can be supported from upstream to downstream. The gap in the current regulations is that they are still localized in some provinces, so they are not yet nationally comprehensive.
The need for land for sago crops is getting higher because the availability of land on the water's edge is starting to decrease due to used as a settlement.	Policy the government through Jayapura Regency Regional Regulation Number 3 Year 2000 on the Preservation of Sago Forest Areas has discussed the importance of preserving the sago forest area. The regulation limits the land conversion that occurs in the Jayapura Regency sago forest area, so as to reduce the rate of deforestation.	The current condition is inversely proportional to the regulation. Sago land that is included in the forest conservation area has experienced land conversion due to oil palm plantations and national strategic food barn projects. Governmen Indonesia should reconsider its prioritization food security via food barn projects in sago forest areas. The regulations set regarding the preservation of the area must be on a national scale.

Table 3 explains the solutions that can be done by the Government of Indonesia based on the current problems of sago development as a food commodity. Solutions that can be developed to solve the problems of sago development in Indonesia focus on national government policies. The obstacles currently faced are community knowledge, facility fulfillment, and deforestation of sago areas. Government policy on a national scale aims to support the sustainable development of sago through education to the community, fulfillment of supply chain facilities, and prevention of deforestation through food diversification. Government policies can support efforts to develop and increase sago productivity on a national scale, so that sago can become a major food commodity for people in Indonesia.

4. Conclusions

Sago development in Indonesia has great potential as a sustainable food solution that is environmentally friendly and suitable for Indonesia's tropical natural conditions. Currently, national food estate projects are still too focused on non-natural commodities such as cassava and corn, which require large areas of land and large resources. In fact, sago

as a local plant that grows naturally in regions such as Papua has advantages in terms of productivity, energy content, and resistance to environmental changes.

However, the development of sago as a major food commodity in Indonesia still faces a number of major obstacles: low community knowledge of agroecological cultivation methods, not yet optimal supply chain of the sago industry from upstream to downstream, and the reduction of sago natural land due to land conversion for settlement and development. From the analysis of six research journals and several national and regional policies, it is known that existing regulations such as MOA 134/2013 and regional regulations in Maluku and Jayapura have shown attention to sago management. However, their implementation is still not effective enough to solve the problems in the field, especially in terms of knowledge transfer, infrastructure facilities, and land protection.

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