A Review of Metroxylon Sago Plant Restoration Towards Recovery Populations With Special Emphasis on Lampung

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Abstract. Rumbia or (*Metroxylon sago*), which has a long history of economic benefits for sago farmers, naturally grows on Lampung Province, Indonesia. In one of the fragmented areas with scattered trees, the sago habitat is now in a state of decline. The reduced area of sago is due to the pressures that are several causing. The sago tree is well known for its natural growth and ability to adapt, thanks to the readily available planting sites with good conditions. To make the program easier, it is necessary to provide access to essential information and data. To this end, the identification of the remaining populations and their geographical habitats, the assessment of the genetic capacity of the population, the verification of the suitability of propagation material sources, and the implementation of supplementary planting and infusion of propagation material, if necessary, can be achieved. To guarantee its compliance, the government must provide support through policies on how agricultural and forestry areas can be used in the development of Lampung sago. This paper describes the current status and develops recommendations for the recovery of Lampung Metroxylon populations in areas that are difficult to convert to rice fields and other intensive cultivation.

Keywords: economic benefit, fragmented, metroxylon, natural growth, propagation material

1 INTRODUCTION

Lampung Province is recognized for its natural distribution of sago (*Metroxylon sago*) plants, locally known as Rumbia. Sago Lampung pertains to the sago plants found in Lampung Province. There is relatively little published information on this topic, possibly because the potential of Sago Lampung is not as extensive as that

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of the sago plants found in Meranti-Riau, Maluku, and Papua. Sago plants can be viewed from various perspectives, including local wisdom and national policy [1], as well as their potential to support food security [2].

The literature review yielded limited information on sago in Lampung Province, with reports by [3], [4], [5], and [6]. It is important to note that the results presented in this study remain objective, without any subjective evaluations. However, sago plants are still present in various locations in Lampung, particularly in the districts of South Lampung, Central Lampung, and West Lampung. Additionally, there are several sago starch processing companies operating in the South Lampung district. The sago plant has a rich history as a commodity that carries economic significance and offers advantages to sago farmers. Prior to 2005, various selling methods for sago stems were prevalent in multiple locations of small-scale factory collections engaged in sago starch cultivation. The cultivation inputs and harvesting of sago plants in Lampung Province were deemed cost-effective due to their inherent ability to grow and propagate naturally, aided by numerous saplings for regeneration. Collaborative sago harvesting and household-level sago starch processing are feasible owing to low technological requirements and do not necessitate complex infrastructure.

In 1986, reported that the sago forest area in Indonesia was 4.2 million hectares [7]. However, [8] reported in 2011 that the area of sago forests had decreased to 1.1 million hectares, resulting in a 3.1 million hectare decline. This decline highlights the serious threat to Indonesia's national sago forests due to land use change into both agricultural land and development infrastructure facilities. An exact evaluation of the effects of the sago forest conversion policy on rice paddy areas has substantial implications for alterations in environmental factors and the carrying capacity [9][10]. Cultural changes in consumption patterns from sago to rice and regional/national development policies, such as the placement of transmigration and the acceleration of regional development, have led to a reduction in sago forest areas in Indonesia. Additionally, fragmentation of sago populations is prevalent in Lampung Province, resulting in a significant decrease in the area and narrowing of sago plants. One condition that is evident from the Provincial and District Statistics Agency data is the lack of information on the potential area for sago plant cultivation and sago starch production for 2020-2023.

The implementation of Presidential Instruction No. 20 of 1979 aims to diversify food sources and fulfil the national carbohydrate requirements using other grains apart from rice. One condition that is evident from the Provincial and District Statistics Agency data is the lack of information on the potential area for sago plant cultivation and sago starch production for 2020-2023. The sago plant presents a viable option to meet this goal. Efforts have recently been amplified to enhance national food security through diversifying crops beyond rice, with an aim to reduce long-term rice dependency. The 2020-2024 National Medium-Term

Development Plan (RPJMN) recognises growth in the national sago industry. Given sago's significance as a food source intertwined with community life in some regions, the Government prioritises social and cultural aspects surrounding sago in the 2020-2024 RPJMN. Efforts to enhance the economy of communities through sago management must be carried out sustainably when it is tied to indigenous peoples' land.

The sago plant development programme in Lampung province has yet to be realised, although it has been implemented in several other regions of Indonesia, including Meranti Islands [11], Jayapura Regency [12], underdeveloped village locations[13], East Seram Regency [14], Luwu Regency [15], and the sago plate industry [16], the development of sago for the Akit tribe [17] and Anggarbei District [18] involves various restoration activities, such as revegetation.

The use of vegetation buffers is an effective measure to mitigate negative environmental impacts. This process aims to establish vegetation in previously lost areas and create buffers that protect water quality from runoff that can result from residential and agricultural activities. The advantages of restoring ecosystems and the environment comprise (1) aiding the amplification of biodiversity on land and in water by incorporating technologies that deliver high yield and potential while minimising harm, and (2) preserving ecological equilibrium. Revegetation efforts concentrate on areas that were once naturally populated by sago plants but have since vanished. In sago habitat areas facing population decline and fragmentation, rehabilitation initiatives for sago plants are undertaken to promote population recovery. This paper aims to provide recommendations for supporting the restoration and rehabilitation of sago plants in Lampung Province.

2 MATERIALS AND METHODS

2.1 Materials

This study utilizes data on sago plants in Sumatra and Lampung Province, including information on land area, productivity, potential, and obstacles for food, feed, energy, and environmental sustainability. The data was gathered from reliable and up-to-date journal literature and reports. Technical terms are explained as required, and the data is presented in a clear and concise narrative format to create a comprehensive paper. Before publication, the manuscript underwent a thorough review by a team of researchers who are members of the manuscript drafting across Research Centre at the National Research and Innovation Agency (BRIN) in order to produce a comprehensive paper.

2.2 Methods

2.2.1 The literature study aimed to trace the potential and history of the development of sago plants and their role in the economy of sago plant management farmers in Lampung Province, as well as to review their current status

2.2.2 The field study was conducted to further investigate these findings.

2.2.3 The direct evaluation of sago plants' existence was carried out in multiple natural habitats across various locations in Lampung Province.

3 RESULTS AND DISCUSSION

3.1 Identification and Distribution of Sago Populations in Lampung Province.

Rumbia or sago palm (*Metroxylon sago)* naturally grows and spreads across several districts in Lampung Province. Data on the potential and distribution of sago plants in Lampung Province is scarce and difficult to obtain. To ensure the preservation of Sago in Lampung Province, a field evaluation was conducted to identify and map its geographical habitat. The fragmented populations of sago plants in the South Lampung Regency and Central Lampung Regency are displayed in Figure 1.

Sago Plantation in South Lampung Regency

Sago Plantation in Central Lampung Regency

Figure 1. Fragmented Metroxylon sagu population in Lampung Province

The potential of sago as a plant with a wide-ranging scope of use encompasses various areas, including: (1) its future use as environmentally friendly food due to its relatively low environmental impact during cultivation; (2) utilization of sago as food; (3) use of sago as an industrial raw material; (4) potential use of sago as an energy source; (5) usage of sago as animal feed; and (6) utilization of sago starch processing waste. The cultivation of sago plants requires less intensity than other crops as regeneration is enabled through natural saplings near the plant, and plant maintenance is not demanding.

3.2 Genetic Potential of Sago Populations and Suitability of Propagation Materials

Information regarding the genetic potential of sago in Lampung Province is limited due to its restricted publication information regarding the genetic potential of sago in Lampung Province is limited due to its restricted publication. Hence, a description of the genetic potential of sago populations in Lampung is of significant importance. Genetic potential is primarily determined by individual genetic factors and represents the maximum ability of the plant. To determine the genetic potential of the sago population, it is essential to have an understanding of its diversity and heritability. Genetic diversity is crucial in conservation activities as it aids in the preservation of populations and rehabilitation from detrimental impacts. Knowledge of sago's genetic diversity is vital for selecting propagation materials. It is crucial to objectively identify the genetic diversity of fragmented populations to determine the amount of diversity retained therein. It is crucial to objectively identify the genetic diversity of fragmented populations to determine the amount of diversity retained therein. Explanation of technical term abbreviations is imperative. It is crucial to objectively identify the genetic diversity of fragmented populations to determine the amount of diversity retained therein.

This information is essential in selecting sago plant propagation materials. An explicit structure with logical progression and causal connections between statements should be maintained. Genetic diversity is vital for maintaining reproductive vitality, disease resistance, and adaptability to varying environmental conditions in which a species thrives. If information on the genetic diversity of sago populations in Lampung Province is available, the infusion of genetic material from outside the Lampung population could be explored**.** [19] researched the genetic diversity of sago from several Papua and Sumatra populations, and [20] studied the Sorong population, however, information on the genetic diversity of sago from Lampung has yet to be presented. It is, therefore, imperative to investigate the genetic diversity of the Lampung sago population.

3.3 By enacting Presidential Regulation No. 22/2009, the government aims to promote production and accelerate diversification of food consumption based on local resources. The regulatory improvements made in Law No. 7/1996 on Food revealed that the law prioritizes the establishment of a food safety system, neglecting the importance of food security, self-sufficiency, and sovereignty. Therefore, stakeholders across sectors are undertaking various efforts to modify existing legislation in response to the complex issues surrounding food, particularly food security. One such effort is to increase the diversity of locally-sourced foods through farm-based programs that promote the use of wet land, utilizing an integrated agricultural system [21]. Other strategies include a comprehensive approach to sago development [22], adjustments to local food perceptions [23], and development of sago while considering environmental quality [24].

3.4 Sago plants have the potential to become a preferred crop in Lampung Province's non-rice food diversification program, given the numerous advantages they offer, including accessible development land, cultivation expertise, and efficient product processing. [25] found that each sago tree has the potential to produce 200-400 kg of starch, resulting in intensive planting with a population of approximately 100-200 trees per hectare. It is assumed that each tree produces 300 kg of starch, resulting in a yield of 30-60 tons of starch per hectare of sago plants. The R/C ratio for sago farmers is calculated at 4.14. If the value of the R/C ratio is greater than 1, the business is profitable and viable for cultivation.

3.5 Constraints and Limitations of Thatch (*Metroxylon sago*) Development in Lampung Province.

3.5.1 Obstacles to Restoring Sago Farmer Trust Psychological constraints. are a major hindrance to regaining and cultivating interest in sago plant cultivation. Limited expenses in producing sago plant propagation materials (seeds), wetland ownership, remote land locations, potential market expansion, the duration of sago plant harvesting & pressure from annual crop businesses. Government attention remains insufficient.The Provincial and local District Governments are showing insufficient interest in the cultivation of sago plants, as demonstrated by the lack of precise data regarding the area of sago plantations.

3.5.2 Furthermore, there is a constrained market for sago food and processed goods. This situation arises from the availability and accessibility of sago food, as well as the local tradition in Lampung Province where people are not familiar with various foods made from sago starch odour ingredients.

3.5.3 Additionally, the utilization of sago processing technology at the farmer level remains basic, necessitating a package of sago starch extraction technology that can be transferred to different sago plant locations.

3.5.4 Furthermore, the price of sago food is relatively lower than other types of food. This issue is partially caused by the limited public knowledge of sago consumption patterns.

3.5.5 Additionally, both government and private investment in sago agriculture and its processed products have been lacking.

3.5.6 Another factor is the intense competition of sago food with other food sources. Moreover, the location of sago plants in wetlands often poses accessibility challenges.

3.5.7 The constraints to growing sago crops in wetlands include several factors: (1) Wetland fertility; (2) Fluctuating water regimes that cause waterlogging during floods/tides and shallow and dry land during the dry season; (3) The high cost of tillage; (4) Limited knowledge of farmers, and (5) Farming in wetlands must be comprehensive.

3.6 SWOT Analysis

A strategy for the development of sago palm can be formed based on a SWOT (strengths, weaknesses, opportunities, and threats) analysis derived from the information on its potentials and problems in Table 1.

Table 1. Presents the results of the SWOT analysis of Sago Plant Development in Lampung Province.

Internal Factor / External Factor	**Strengths (K)** o Potential Wetlands - Swamps for Sago are quite extensive o Potential suitability of sago-type plants to naturally grow o Have basic sago cultivation experience	**Weaknesses (L)** o Limited budget for sago development & Budget not available o Policy & Support is not optimal o Small-scale investment o Low adoption rate
Opportunity (P) o Restoration with revegetation & rehabilitation of sago population o Realization of non-rice food diversification program o Increased production of sago starch o Utilization of vacant land o Availability of new job opportunities	**SO Strategy (Strength-Opportunity)** o Utilization of vacant land (wetland-swamp) for revegetation & rehabilitation of sago plants o Sago development with low-cost cultivation concept o Development of business interest in product diversification with the basic ingredients of sago starch	**WO Strategy (Weakness-Opportunity)** o Equipping the extension system to improve sago revegetation efforts with mentoring o Increase the investment value of sago cultivation development on vacant land o Market assurance, production continuity and partnerships.
Threat (A) o Pressure on the existence of sago population area o Competition with rice food o Low interest in sago Lampung business	**ST Strategy (Strength - Threat)** o Sago cultivation assistance by optimizing sago starch productivity, improving starch extraction skills, sago starch raw material-based products and entrepreneurial spirit for sago starch business resilience.	**WT Strategy (Weakness-Threat)** o Ensure the existence of the current sago population area with budget support and continuous assistance o Improve the readiness of all stakeholders related to non-rice food diversion programs by improving supporting programs and policies, developing investment, infrastructure capabilities of non-rice food diversification actors and budget policies.

A strategy for developing the Lampung sago, based on a SWOT analysis (strengths, weaknesses, opportunities, and threats), can be formulated according to the information gathered. Table 1 presents the outcomes of the analysis. The sizeable expanse of wetlands and swamps that have not yet been utilised for rice paddy fields, the potential suitability of sago-type plants for natural growth, and a basic knowledge of sago cultivation passed on through generations are some of Lampung sago's main strengths. The main weaknesses include a limited development budget, unavailability of funds, suboptimal policy and support, small-scale investment and low levels of adoption. Despite these challenges, opportunities for development exist through initiatives such as reviving vegetation, rehabilitating sago populations, diversifying non-rice food programs, boosting sago starch production, utilizing vacant land and generating new employment. Challenges that could impede the

development of Lampung sago include reduction in sago population areas due to rice fields, fierce competition with rice as a food commodity, and low motivation for sago businesses. Lampung Province can employ strategies for sago development based on its strengths and opportunities (KP), weaknesses and opportunities (LP), strengths and threats (KA), and weaknesses and threats (LA) as outlined in Table 1 above. Sago development strategies could be emphasised based on particular policy aspects, as highlighted by [26], relating to sago development policies centred around Small and Medium Industrial Centre and to augment the added value of businesses relating to sago plants [27].

4 CONCLUSION

The implementation of restoration activities, including revegetation and rehabilitation of sago plant populations in Lampung Province, holds potential for realising population recovery efforts and supporting non-rice food diversification.It is essential to provide sago farmers with assistance to renew their interest in sago cultivation and business through various capital support schemes and other technical aspects.

The advancement of sago in Lampung Province faces multiple hindrances, such as inadequate government attention, limited market opportunities for sago food and processed goods, rudimentary local-level sago processing technology, and insufficient government funding. The SWOT analysis-based development strategy concentrates on returning the sago population in wetlands by re-vegetating and restoration sago plants.

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