East Asian Journal of Multidisciplinary Research (EAJMR)
Vol. 4, No. 9, 2025: 4649 - 4660

Morphology of the Soil Where Sago (*Metroxyllon* spp .) Grows in Asa Hamlet in Ouw Village, East Saparua District, Central Maluku Regency

Charles Silahooy
Soil Science Study Program, Department of Agricultural Cultivation, Faculty of Agriculture, Pattimura University, Ambon, Indonesia
Corresponding Author: Charles Silahooy charlessilahooy@gmail.com

A R T I C L E I N F O

Keywords: Cambisol, Metroxylon spp., Sago, Soil Morphology

Received : 15, August
Revised : 09, September
Accepted: 25, September

A B S T R A C T

This study aims to describe the morphological characteristics of the soil at the sago (***Metroxylon* spp**.) growing site in Asa Hamlet, Ouw Village, East Saparua District, Central Maluku Regency. The method used was a descriptive survey by opening a soil profile in the sago field and observing soil color, texture, structure, consistency, and horizons. The results showed that the soil has three main horizons, namely horizon A (0–20 cm), horizon Bw (20–50 cm), and horizon BC (50–80 cm). The upper horizon is dark brown to blackish with a silty clay texture and high organic matter content, while the lower horizons are yellowish brown to grayish brown with clay to clay loam textures and harder consistency. The conclusion of this study is that the soil in the sago growing site is moderately developed, has good drainage, is classified close to Cambisol, and supports optimal sago growth. These conditions indicate that the hilly land of Asa Hamlet has potential for sustainable sago development, provided that soil and water conservation are taken into account.

DOI prefix: https://doi.org/10.55927/eajmr.v4i9.390
ISSN-E: 2828 – 1519 (Online)
https://mtiformosapublisher.org/index.php/eajmr

INTRODUCTION

Soil is a key component of terrestrial ecosystems that supports plant growth by providing anchorage, nutrients, water, and habitat for microorganisms. In tropical regions such as Maluku, where geographic and climatic conditions are unique, understanding soil characteristics is essential for sustainable land management (Ripaini *et al*., 2025; Ely *et al*., 2023).

Sago (***Metroxylon* spp**.) is a strategic local crop in Maluku that functions not only as a staple food but also as an economic and cultural resource. This species is highly adaptive to marginal soils, including poorly drained areas. Several studies in Maluku have examined sago from different perspectives. Sanusi *et al*., (2020) and Elly *et al*., (2023) analyzed soil characteristics under sago stands in inundated areas, while Sahetapy and Karuwal (2022) described morphological variation among sago types. Komul *et al*., (2019) revealed the diversity and starch potential of sago, and Haduaci *et al*., (2024) reported high biomass potential in sago forests.

However, most of these studies focus on sago in lowland or swampy environments, while research on sago growing in hilly regions remains limited. This represents a clear research gap, especially in understanding the soil morphology that supports sago in upland areas. Soil morphology including horizon development, color, texture, and structure directly influences water retention, drainage, and nutrient availability, which are critical for plant productivity (Ripaini *et al*., 2025). In hilly Maluku, soils such as Cambisols are common (Batu *et al*., 2019; Riry, 2023), and although relatively young, they can support adaptive crops like sago due to their good moisture storage capacity.

Based on these considerations, the research problem can be formulated as follows: how is the soil morphology in Asa Hamlet that supports the growth of sago palms? The novelty of this study lies in its focus on upland soils, since sago is generally associated with lowland or swampy areas. The contribution is to provide a scientific basis for mapping the potential of highland soils for sago development and to support sustainable land use strategies based on local resources. Therefore**,** it is necessary to conduct research on the soil morphology where sago palms (***Metroxylon* spp**.) grow in Asa Hamlet, Ouw Village, East Saparua District, Central Maluku Regency to provide a scientific overview of soil characteristics and opportunities for sago palm development in the region.

THEORETICAL REVIEW

Sago palm (Metroxylon spp.) is a strategic staple crop in Indonesia due to its high adaptability to diverse environmental conditions. Sarie *et al*., (2023) highlighted that morphological variations of sago species are closely linked to their ecological distribution, demonstrating the influence of environmental factors on growth. Similarly, Al Manar *et al*., (2023) reported that morphological diversity of sago in Lingga Regency is shaped not only by genetic factors but also by soil properties and landform characteristics. In line with this, Dimara and Auri (2023) emphasized the role of landform in determining the spread of sago habitats in Yapen Islands, while Irawan *et al*., (2024) showed that groundwater levels and drainage conditions directly influence plant development and starch yield.

Furthermore, Bintoro *et al*., (2024) confirmed the morphological diversity and production potential of sago accessions in South Sulawesi, which are strongly associated with soil and hydrological conditions. Jayusman *et al*., (2024) stressed the need for ecological approaches to restore sago populations, while Jaya *et al*., (2024) proposed agroforestry as a sustainable land rehabilitation strategy that can also be adapted for sago ecosystems. In addition, Bintoro *et al*., (2018) pointed out that the expansion of sago cultivation is closely related to soil type, topography, and water regimes, reaffirming the crucial role of soil morphology in determining sago productivity and sustainability.

Synthesizing these findings, it is evident that although extensive studies have been conducted on the morphology, ecology, and cultivation of sago, most research has focused on lowland, swamp, and peatland environments. Studies on sago growth in hilly and upland areas remain limited, despite their ecological potential for sustainable cultivation. This research gap underpins the novelty of the present study, which investigates soil morphology in Asa Hamlet, East Saparua, as a natural habitat for sago palms. The contribution lies in providing a scientific basis for understanding upland soil suitability for sago development, thereby supporting local food security and sustainable land-use strategies in Maluku.

METHODOLOGY

Type of Research

This study employed a descriptive survey method aimed at identifying and describing the morphological characteristics of soils that support sago palm (***Metroxylon* spp**.) growth. The approach was primarily qualitative and descriptive, without statistical hypothesis testing.

Research Location and Time

The research was conducted in Asa Hamlet, Ouw Village, East Saparua District, Central Maluku Regency, an upland area where sago palms naturally grow. The site was chosen purposively because of its ecological potential and cultural relevance to local communities. The study was carried out over a period of two months (April–May 2025), covering preparatory work, field observations, data collection, and analysis.

Population and Sample

- Population: All soils in Asa Hamlet where sago palms naturally grow.
- Sample: Representative soil profiles located under sago stands.
- Sampling technique: Purposive sampling was applied by selecting soil sites where sago palms were observed to grow vigorously (healthy stems, good canopy, and multiple suckers). A representative soil profile was then excavated and described in detail.

Research Instruments

The instruments used included:

- Soil description card (to record soil horizons, depth, color, texture, structure, consistency, pH, moisture, and organic matter).
- Semi-structured interview guide for informants.
- Field equipment: GPS, Abney level, auger, shovel, roll meter, and digital camera.
- Materials: Munsell Soil Color Chart, pH indicator strips, 10% HCl, 30% H_2O_2, distilled water, plastic bags, and labels..

Research Procedure

- Site identification: Sago growing areas were identified with the help of informants.
- Profile excavation: A soil profile pit was dug in a representative location to expose horizons.
- Field observation: External factors (slope, vegetation, drainage, landform) and internal soil properties (horizon depth, texture, color, structure, consistency, moisture, and pH) were recorded.
- Sample collection: Selected soil samples were taken for simple field tests.
- Interview: Semi-structured interviews were conducted with local informants to complement field observations.
- Documentation: Photos and GPS points were recorded to verify data reliability.

Secondary Data

Additional supporting data were collected, including:

- Administrative maps of Ouw Village,
- Land use maps of East Saparua District, and
- Climate and rainfall data from BMKG and related agencies.

Data Analysis

- Soil morphology was analyzed descriptively by comparing horizon characteristics, texture, and structure.
- Soil color was determined using the Munsell Soil Color Chart, while texture was analyzed using the feel method.
- Soil classification referred to the FAO/WRB and USDA Soil Taxonomy systems.
- Interview data were analyzed qualitatively to capture community perceptions of land suitability for sago.
- Triangulation of field data, interviews, and secondary sources was conducted to ensure validity.

RESULTS

General Characteristics of the Study Site

The research was carried out in Asa Hamlet, Ouw Village, East Saparua District, Central Maluku Regency, an area with varied topography and an

elevation of approximately 573 m above sea level. The vegetation is relatively dense, dominated by tropical shrubs and shade trees, within which sago palms (***Metroxylon* spp**.) grow naturally. The good growth performance of sago palms indicated by large trunk diameters, numerous saplings, and vigorous stands suggests that the ecological conditions of this area support sago development.

Figure 1. Sago palms (*Metroxylon* spp.) in Asa Hamlet, Ouw Village

These observations are consistent with Sahetapy and Karuwal (2015), who emphasized that habitat factors such as shade, soil moisture, and protection from erosion strongly influence sago growth. The presence of a stable microclimate in Asa Hamlet, with sufficient humidity and filtered light under the canopy, contributes to the favorable conditions for sago growth.

Soil Morphological Characteristics

Soil profile analysis revealed three horizons: horizon A (0–20 cm), horizon Bw (20–50 cm), and horizon BC (50–80 cm) (Table 1). The upper horizon (A) is dark brown to black, with a silty clay texture, soft consistency, and high organic matter content, indicating fertile topsoil. The Bw horizon is yellowish brown, with clay texture and moderately firm consistency, while the BC horizon is grayish brown, clay loam, and harder in consistency.

Table 1. Description of Soil Morphology Where Sago Grows in Asa Hamlet, Ouw Village

Depth (cm)	Soil Color (Wet)	Texture	Soil Structure	Consistency	Humidity	Organic Materials	Soil Horizon
0 – 20	Dark brown to black (7.5YR 3/2)	Silty clay	Fine granular to sub rounded	Soft, plastic when wet	Wet	High	Horizon A (Topsoil)
20 – 50	Yellowish brown (10YR 4/4)	Clay	Medium angular blocky	Slightly hard, slightly plastic	Moist	Moderate	Horizon Bw (Alteration)
50 – 80	Grey brown (10YR 5/2)	Clay loam	Roughly angular lumps	Hard when dry	Moist	Low	Horizon BC (Transition)

Figure 2. Soil profile where sago grows in Asa Hamlet, Ouw Village

The soil characteristics indicate a moderately developed profile, classified close to Cambisol, which aligns with Batu *et al*., (2019) who reported that Cambisols are common in hilly landscapes of Maluku. Cambisols, although relatively young, provide adequate porosity, moderate drainage, and sufficient nutrient storage capacity factors that directly support sago growth. Sanusi *et al*., (2020) similarly found that sago thrives in soils with moderate drainage and high organic matter, particularly in the upper horizon.

Relation of Soil Morphology to Sago Growth

The presence of a fertile A horizon with high organic matter ensures nutrient availability for sago roots. The clay to silty clay texture enhances water retention, which is essential in upland conditions where rainfall infiltration may be high. Meanwhile, the Bw horizon contributes to soil stability and water storage, preventing excessive leaching. Such characteristics create an optimal environment for sago root systems to develop.

These findings strengthen the view of Komul *et al*., (2018), who highlighted that soil fertility and water availability are key determinants of sago productivity. Similarly, Ely *et al*., (2021) emphasized that soil development in tropical uplands plays a critical role in determining vegetation adaptability. Thus, the morphological conditions of Asa Hamlet soil explain the good performance of sago stands observed in the field.

Supporting Vegetation and Ecological Balance

The surrounding vegetation, including understory plants like wild pineapple (Ananas bracteatus) and tropical shrubs, contributes to soil stability and moisture conservation. The ecological complexity supports a balanced micro ecosystem that prevents erosion and maintains soil fertility. These conditions correspond with Ripaini *et al*., (2025), who noted that vegetation soil interactions are essential in sustaining tropical soil functions and ensuring long term productivity.

Implications for Sago Development

The study confirms that the hilly soils of Asa Hamlet, although classified as relatively young Cambisols, are suitable for sago growth due to their favorable physical and morphological properties. This finding contributes to filling the research gap, as most previous studies focused on lowland or swampy areas (Sanusi *et al*., 2020; Elly *et al*., 2023). The novelty of this research lies in demonstrating that upland soils can also provide suitable conditions for sago, thereby expanding the potential land base for sustainable sago cultivation.

DISCUSSION

Morphological Characteristics of Soil under Sago Stands

The soil profile in Asa Hamlet exhibits three horizons A, Bw, and BC with variations in color, texture, structure, and consistency that indicate moderate soil development. The dark brown to black A horizon, rich in organic matter, provides a fertile layer that supports the establishment of sago roots. The Bw horizon with clay texture contributes to water retention, while the BC horizon, although denser, still facilitates adequate moisture storage. These characteristics reflect soils that are moderately developed and classified close to Cambisols.

This finding is consistent with Sanusi *et al*., (2020), who reported that sago grows well in soils with moderate drainage and high organic matter in the surface horizon. Similarly, Riry and Tetelepta (2023) highlighted that Inceptisols and Cambisols in Maluku often support adaptive crops because of their fine texture and stable structure, features that were also observed in this study.

Soil Suitability for Sago Growth

Sago (***Metroxylon* spp**.) is recognized as a plant capable of adapting to marginal soils, including poorly drained and clay-rich environments. The results of this study confirm that the soils in Asa Hamlet, although relatively young, have favorable physical properties for sago growth. The silty clay texture in the topsoil improves water retention while preventing excessive leaching, ensuring root access to nutrients and oxygen.

Elly *et al*., (2022) also noted that clayey soils with moderate porosity allow sago to maintain optimal physiological processes as long as waterlogging does not occur. This corresponds with the conditions found in Asa Hamlet, where the soils are moist but not permanently inundated. Therefore, the morphological characteristics of this site provide a natural medium that supports the healthy development of sago palms.

Influence of Topography and Elevation

The site elevation of 573 m above sea level contributes to cooler microclimatic conditions, stable soil moisture, and moderate drainage. Although sloping areas are susceptible to nutrient leaching, the presence of forest vegetation and understory plants reduces erosion and maintains soil fertility. These findings are in line with Elly *et al*., (2022), who emphasized that upland areas with good vegetation cover can sustain crops like sago through improved soil conservation functions.

The ability of sago to grow in hilly landscapes, as demonstrated in this study, extends the ecological range of the plant, which is commonly associated with swamps and lowlands. This provides new evidence that sago can also thrive in upland areas under appropriate soil and microclimatic conditions.

Soil-Forming Factors and Ecological Implications

The soil morphology of Asa Hamlet reflects the combined influence of fine-textured parent material, high rainfall, and forest vegetation cover. These factors promote the formation of soils with incomplete but functional horizons that remain fertile enough for sago development. Jalianti *et al*., (2025) explained that such combinations are typical in tropical uplands, producing soils that are underdeveloped yet ecologically productive.

This study reinforces the importance of integrating soil morphology analysis into land-use planning. As suggested by Komul *et al*., (2023), mapping soil properties is crucial not only for assessing land suitability but also for ensuring the ecological sustainability of sago based systems.

Implications of the Findings

The results demonstrate that Asa Hamlet provides a suitable natural habitat for sago cultivation, despite its hilly topography. The presence of fertile topsoil, adequate drainage, and favorable microclimate confirms that sago growth is not limited to swampy lowlands but can extend to upland soils with Cambisol characteristics.

This research fills a significant gap in previous studies, which largely focused on sago in lowland or swamp ecosystems. By highlighting the potential

of upland soils, this study contributes to the scientific basis for expanding sago cultivation areas. Moreover, the findings offer practical implications for sustainable agroforestry and soil-water conservation strategies in Maluku.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

This study concludes that the soil morphology in Asa Hamlet, Ouw Village, East Saparua District, Central Maluku Regency, is suitable for the natural growth of sago palms (***Metroxylon* spp**.). The soil is moderately developed, classified close to Cambisol, with three main horizons (A, Bw, BC). The A horizon is fertile, rich in organic matter, and has a silty clay texture that enhances water and nutrient retention. The Bw horizon provides structural stability, while the BC horizon maintains adequate moisture storage.

These characteristics, combined with the site's hilly topography (573 m above sea level) and favorable microclimatic conditions, demonstrate that sago can thrive not only in swampy lowlands but also in upland environments. This finding addresses the research gap by confirming that upland Cambisol soils offer ecological potential for sustainable sago development.

Recommendations

Based on these findings, it is recommended that the soils of Asa Hamlet and other similar upland areas in Maluku be considered for sago development programs, provided that soil and water conservation measures are applied to minimize erosion and nutrient loss. The integration of sago palms into agroforestry systems is also suggested, as the presence of shade trees and understory vegetation can help maintain soil fertility and ecological balance. Furthermore, more detailed soil morphology and fertility mapping across different upland sites is needed to broaden the scientific basis for sago land suitability classification. Finally, local government support is crucial to incorporate upland sago development into sustainable land-use planning and food security strategies.

FURTHER STUDY

This study has successfully identified the morphological characteristics of the soil where sago grows in Asa Hamlet, which shows the potential of the land as a natural habitat for this plant. However, to support the sustainable development of the sago agribusiness, future research needs to expand its scope to a more detailed analysis of soil chemical properties, such as nutrient content (N, P, K), pH, and organic carbon, which can affect sago productivity. In addition, research on appropriate soil and water conservation strategies for the hilly terrain in this area is also very important to prevent erosion and maintain soil fertility. Genetic analysis of the local sago population could also be a focus of further study to understand its adaptability to specific environmental conditions.

ACKNOWLEDGMENT

The author extends their sincere gratitude to the people of Asa Hamlet, Ouw Village, who have given permission, assistance, and valuable information throughout the implementation of this research. The full support from the academic community of the Soil Science Study Program, Department of Agricultural Cultivation, Faculty of Agriculture, Pattimura University, has also been very meaningful. Special thanks are given to the parties involved in providing secondary data, logistics, and laboratory facilities that have supported the smooth running of the research.

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