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## Utilization of biomass from Sago (*Metroxylon* sp) by local ethnic around the Sentani Lake Jayapura-Papua Province

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**Abstract.** Sago is multi-functional crops for local ethnics living at coastal and low land areas in Papua as main carbohydrate and raw-material of traditional houses. This research is designed to document the utilization and socio cultural values of sago biomass by local ethnic around the Sentani Lake, Jayapura. Field survey and structural interview were used to collect data at Yoboi and Sereh villages. The results indicate that carbohydrates were extracted from pith and other sago's biomasses were used for green material for various puIDRoses. Leaf are for floor mate, filter starch, carrying bags, housing roof and fishing trap. Sago fronds are for extraction chamber and sedimented starch. Rounded fronds are used for house wall, burning media for lime stone and planting media boxes. Bark of trunks are for flooring and decking their stilts, balcony and firewood. Residual waste from sago pulp are good media for mushroom, planting vegetables, imago inhibitor, and compost. Its fruits are for wall accessories and necklace. Sago lands is also supply animal protein by providing habitat for hunting animals. Socio cultural values mean that sago is ancestor heritage to be saved, utilized, managed proportionally for next generation. This crop is cultural identity contributed to socio cultural and economic values, but these wisdom values are pressuring recently.

### 1. Introduction

Sago (*Metroxylon* sp) is special palm and has special meaning to the local ethnics lived at the coastal and low land areas in Papua. Papua province has approximately 4,749,424 ha of sago area, where Jayapura district has 79,908 ha, mostly concentrated in Sentani [1]. It is communal sago forest belonging to the Sentani ethnics who live around the Sentani Lake. This palm resources has contributed to the multi values to the local ethnic from one to the next generation [2].

Sentani is the capital city of Jayapura district, where governmental offices, military bases, economy facilities and Sentani aiDRort are located. These facilities are located at around the Sentani Lake. This is the biggest lake in Papua and West Papua province. Sago palm grows naturally around the Sentani Lake, and adjacent to the Sentani aiDRort. Majority of local ethnics of Sentani living concentrate at lake area, and heavy depend on the resources around the lake. Therefore, existence of sago resources and its surrounding environment are vital for the local ethnic. This is applied not only for food security but also for their daily necessities of traditional material, sources of protein as well as economic income.

Many researches have been conducted to determine the diversity [3], productivity [4], growth development and characteristic of sago [5] in Sentani Lake area. Those researches include the potent utilization of residual sago processing for briquettes product [6], residual sago pulp for compost filler [7] and briquettes [8]. However, traditional utilization of biomass from sago in Sentani Lake have not been reported. Therefore, this research is to investigate the various traditionally utilization of biomass



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from sago by local ethnics live around the Sentani Lake, Jayapura. Socio culture and economical aspects of sago to the local ethnics are also investigated.

## 2. Materials and Methods

### 2.1. Research site

This research was conducted at two village around Sentani Lake, namely Yoboi and Sereh Village, and inhabited by local ethnic or Sentani tribe and completed for two months. This research site could be reached by car from Jayapura city for approximately 2 hours.

### 2.2. Data collections

Field work with survey was used to collect the research data, and structural interview were conducted to the selected respondents based on questioners prepared. PuIDRosive sampling was used to select respondents, where two different respondents, general and key respondents, were designed. General respondents are member of community living in the villages areas, actively involved and has right to extract and uses sago resources. 18 and 60 respondents were selected (representing 15% of total village population) for Yoboi and Sereh village, respectively. Key respondents are ethnic leaders, religious person, and village leaders.

### 2.3. Research variables

Research variables consist of variety of utilization of sago biomass from leaf, trunks, fronds, bark, and sago extraction tools used. Socio culture variables include traditional knowledge of sago, philosophical view of sago, and traditional conservation and transfer of knowledge to young generation. Volumetric starch collected from sago extraction and prices of sago starch marketed around Sentani Lake by the Sentani ethnic were also reported.

## 3. Results and Discussion

### 3.1. Results

#### 3.1.1. Sago's biomass utilizations

Traditional utilization of biomass from sago by Sentani ethnic lived around the Sentani Lake are summarized in Table 1, and their corresponding pictures are presented in Figure 1, respectively.

**Table 1.** Traditional utilization of biomass from sago used by Sentani ethnic lived around the Sentani Lake Jayapura-Papua Province

Sago Biomass (local name)	Local name (Indonesian)	Functions	Descriptions of utilization and pictured in Figure 1
<b>Leaf</b> ( <i>Fi yang</i> )	Khanggali ( <i>sarangan</i> )	Sorter or filters	Stopping residual material from sago pulp extracting to enter the sediment chamber (1a)
	Olong ( <i>wadah penampung</i> )	Handling of sago pulp	Mobile container to carry sago pulp from floor into extraction chamber (1b)
	Hougey ( <i>tikar penjemur</i> )	Drying mattress	Multiple drying mattress used for drying agricultural commodity, such cocoa, coconut, etc (1c)
	Imea Yang ( <i>Atap rumah</i> )	Roofing material	Roofing material of working house, huts of the local ethnics (1d)
	Phukhereng ( <i>Perangkap ikan</i> )	Fish trap	Trapping fish for customary ceremony with tighten regulation (1e)
	<b>Sago fronds</b> ( <i>Fena</i> )	Fi ling ( <i>wadah empulur</i> )	Chamber
Me'a ( <i>tiang penyangga</i> )		Standing coloum	Supporting the separating chamber (1g)
Meya ( <i>tiang penahan saringan utama</i> )		Standing coloum for siever	Supporting for siever (1h)

	Hurlai ( <i>penahan wadah ekstrak</i> )	Main colour for starch ( <i>sediment</i> ) chamber	Supporting colour for starch container (1i)
	Khetembi ha ( <i>tali pengikat</i> )	Tinghten material ( <i>rope</i> )	Outer part of the sago fronds used for wrapping or roping-materials (1j)
	Fena ha ( <i>penahan saringan utama</i> )	Barrier material	Filtering sago sediment from outing with water (1k)
	Auma ( <i>bedeng tanam</i> )	Planting boxes	Container for planting media, because all areal are standing on the top of the Sentani Lake (1l)
	Fena imea ( <i>dinding rumah</i> )	House wall	Wall house material (1m)
	Au fena ye hanegokhate ( <i>media bakar kulit bia/kerang</i> )	Calcium burning media	Calcium is need to consum pinang, and calcium is obtained by burning sea shells (1n)
<b>Sago bark</b> ( <i>Rakhele</i> )	Wakhung ( <i>lantai rumah</i> )	Flooring material	House flooring material (1o)
	Ye ( <i>kayu bakar</i> )	Firewood	This wood energy (firewood) for local ethnic (1p)
<b>Sago pulp</b> ( <i>Mele</i> )	Sago starch ( <i>aci sagu</i> )	Sediment of sago pulp	Main source of carbohydrate
	Planting media ( <i>media tanam</i> )	Soil supplement	fibrous material from residual sago pulp (1q)
	Compost ( <i>kompos</i> )	Soil filler	Providing nutrition to the planting media (1r)
	Hem ( <i>Ulat sagu</i> )	Imago	Sources of protein (1s)
	Mushroom	Compost mushroom	Source of protein
<b>Fruits</b> ( <i>Fiole</i> )	Fiole neckless ( <i>kalung adat</i> )	Customary accessories	Accessories for folk dance (1t)



**Figure 1.** Various products made traditionally by Sentani ethnic from sago biomass around Sentani Lake

Table 1 highlights that biomass from sago have been used intensively by the local ethnic around the Sentani Lake for traditional material of daily usages. Three biomasses such as leaf, fronds, and sago pulp, could be simply processed into various green products. In total, there are 22 products derived from sago biomass (Table 1), which could be classified into three class, likes raw material of green products, sources of food, and green building material. One example in utilizing those material is sago fronds. The bottom of sago fronts, which is naturally similar to chamber (as illustrated by Figure 1f) is a perfect material naturally available for extraction chamber. It seems that this material is strong enough, elastic and easy to be used instantly.

### 3.1.2. Sago trunks characteristic and their starch production

Traditionally, Sentani ethnic lived around Sentani Lake has differentiated sago palms into two classes, sago with spiny and without spiny. Locally, sago spiny have five names, namely Bhara, Osokhulu, Rondo, Ruruma and Manno, while sago without spiny have five names, from Yebha, Follo, Wani, Phane, and Hobolo. These ten local names are the main sources of carbohydrate for the local ethnics. Processes of extraction to collect sago starch amongst those ten names are similar and the main differences are the colour and physical appearances (odour and taste) of the starch produced. Field survey for numbers of sago trunks felled per day, pieces of bucked stem per trunks, and volumes of fresh-sago starch collected and expressed in containers are summarized in Tabel 2.

**Table 2.** Local name, numbers of bucked trunks, and their volume of wet sago starch collected from Sentani ethnic live around Sentani Lake

Sago	Local name	Numbers of sago processed by the local ethnic			qualitative starch assessment
		Trunks/day	Pieces of bucked stems per trunks	Container <sup>*)</sup> per trunks	
<b>Without spiny</b>					
	Yebha	3	21-23	7-9	Good
	Follo	3	15-18	3-4	Good
	Wani	2	18-20	5-8	Good
	Phane	1	10	3-4	Good
	Hobolo	1	10	3-4	Good
<b>Spiny</b>					
	Osokhulu	3	15-18	5-6	Good
	Bhara	3	12-13	5-6	Good
	Rondo	2	8-10	3-4	Good
	Ruruna	1	8-10	3-4	Good
	Manno	1	15-17	3-4	Bad

<sup>\*)</sup> an average weight for 35 kg of fresh sago starch

Table 2 highlights that both sago with spiny and without spiny are processed to collect sago starch for local ethnics. In average, 1-2 sago trunks are harvested per day in Yoboi and Sereh villages. After been felt using chain saw, sago trunks are bucked into 50 cm long and resulted 21-23 bucked stems of Yebha and 15-18 bucked stems of Osokhulu. From those bucked stems, 7-9 containers of wet sago starch were collected from Yoboi and 5-6 containers from Osokhulu. Both are reported with good qualitative starch sago assessment. Sago pulp were collected from sago pith using the grated sago engine [9].

### 3.1.3. Socio culture aspects of sago

According to their own tradition, Sentani ethnic called themselves as phuyakka, *phu* meaning water and *yakha* meaning clam and clean water. It has a meaning that the cleanest and calmness water is their ancestor symbol for their habitat, where the Sentani Lake is inhabited by 27 villages of the local ethnics. All Sentani ethnics had customary right (*mam*) and it is applied to all to those villages. Two basic customary right for Sentani ethnics are, *Erei Khamei* and *Holei Narei*, respectively. The first term has a meaning for full of respects and appreciation to all community members, whereas the last term has a

meaning that all members have duty and responsibility to protect, maintain, save, and provide foods to their family members, customary leader, clan leader, widow and orphans.

A real man locally named as *Ro Khelu Fa* can be attributed to the man who has sago land, could manage his sago lands or orchards, extract sago's starch and to feed as many member community as he could. For Sentani's women (*Manggea Fa*) skills in preparing and serving Papeda (local food made from sago starch with fresh fish sauces) are customary measured for adulthood. Sago forest or orchards (*Fiung akhla*) is ancestor heritage and communal property that could not be offered or inherited directly into young generation, but it has to be managed, maintained and saved together and forever.

Sago starch extraction is identical to communal and women activity but all family members are involved in this activity. Collaboration in sago's trunks processing into starch collection is illustrated in Figure 2.



legends: a. peeling sago bark; b. ripping bucked stem; c. sago pulp production; d. standing coloum from sago's fronds; e. squeezing sago pulp; f. sago's starch or sediment chamber

**Figure 2.** Communal activity of sago's trunk processing into starch collection

Children, women and men are collaborated together to the sago orchards for extracting sago starch known well as *Pangkur sago*. In general, the men (young and mature men) are responsibility for clearing the surrounding sago trunks area prior for cutting, felling sago trunks, bucking and ripping the bucked stem and mechanically processing sago pitch into sago pulp (Figure 2 a-c). Women then are constructed traditional supporting material and tools prepared for manual extraction (Figure 2c). Sago pulp are collected and squeezed intensively to obtain white browning sediment, namely sago starch (Figure 2 e-f).

#### 3.1.4. Economic value of sago resources

When all water is running out from the sediment chambers, wet-muddy sago's starch was obtained (as illustrated in Figure 3a, after been steady for a couple hours, fresh-wet sago starch was collected into recycle rice bag (Figure 3b) and it is ready to be transported into home. For Sentani ethnic, the most common commodity from sago palm is fresh sago starch at approximately 20% MC. It is unique about sago starch that to prevent browning because of oxidation, it is must be soaked with full of clean water, and this water is frequently replaced with the fresh water for period of time such as fortnightly. Single container of wet sago starch, approximately 25 kg, are sold from IDR 300,000- 500,000 at local market or selling from home directly.



Remarks: a. wet-muddy starch; b.; filling fresh starch into container c. starch container ready for transporting or selling

**Figure 3.** Filling muddy starch into containers of recycle rice bags for transporting selling

Sago resources for local ethnic around Sentani Lake is invaluable resources. It means as cultural identity and philosophy. An example of this cultural identify is when proposing women, sago food (*natura*) has to be served to the visitor from the men family. Local cuisine Papeda is the main food for the ceremony.

Sago trunk growth and development are also applied to the philosophy of the Sentani ethnic. Sago palm has growing characteristics straight stem, strong, full of leaf and other epiphytes and all sago palm biomass could provide and supply multi beneficiary to the community. Each member of Sentani ethnic has to be strong as the sago palm, in line with the straightness of sago trunk, and provide beneficiary to all surrounding neighbourhoods.

When the family is extracting sago starch, the results has to be delivered to other members in their clan. It is because the sago forest and orchards belonging to the communal right. It means that this property right is not saleable, but it has to be utilised, managed, and shared together in their clan member. Togetherness, cooperation, kindness, and justice amongst all member of clan.

### 3.2. Discussion

Sago is multi-functional crops for local ethnic around the Sentani Lake [10]. This palm could only grow in specific environmental condition, such as swam area closed to the river, estuarian sea, lake and mangrove area [11,12]. Area around the Sentani Lake is natural and suitable habitat for this carbohydrate producer palm that influence the socio culture of the local ethnics at around the Sentani Lake [13].

Sago palm around the Sentani Lake provide not only main source of carbohydrate for local ethnic but also supply protein from lake fish and animal hunting. It is clear that as multi-functional crops, sago, produces enormous quantity of biomass that could be utilized as raw material, which is totally sustainable and biodegradable. These various biomasses could be classified as green material that could be used as raw material for green construction.

Traditional utilizations of biomass from sago for daily usages from local ethnics around Sentani Lake are indigenous wisdom or traditional knowledge that has been in practice from acestor to next generation. This also are supported by the socio culture values of the local ethnics likes, *Erei Khamei* and *Holei Narei*, which are still being in practice until today. More importantly, the local philosophy for being member of community to have multifunctional contribution to the other is similar to sago as the multi-functional crops.

Recently Sentani is the capital city of Jayapura district, where intensive establishment of infrastructure from local and national government, transportation facilities, economic facilities, and building private houses are taken place. As a result, sago land is declining, and traditional utilization of sago biomass is being replaced with synthetic material such as plastics or their derivative products. These phenomena are serious pressures to the existence of traditional wisdoms in utilizing sago biomass at around the Sentani Lake.



#### 4. Conclusion

It is concluded that sago palm offers various biomass, such as leaf, fronds, barks, and residual sago pulp, that could be simply processed into various traditional products for daily usages by local ethnic around the Sentani Lake. Even though, these utilizations are local scale, this practice has been existed for many generations and recently it is under pressure that should be taken into account. This reflects that sago is multi-functional crops for the local ethnics, not only for staple foods, but also for green material sources.

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