

## A Comparative Study on Technology Adaptation for Sago Starch Extraction in Pacific and Asian Local Regions

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**Abstract** Sago agriculture is closely associated with root vegetable zones. The sago palm still plays a leading role in the cultures of some Asian and Pacific local regions. The methods of sago starch extraction depend on a particular area. Extraction methods in some of these areas were investigated through field surveys and it was established that there were some differences. This study investigates some local areas in a Pacific Island country, Papua New Guinea, as well as local areas in Southeast Asian countries, especially, Indonesia and Malaysia. Extraction of sago palm starch in Papua New Guinea and in Indonesia shows similar processes, except that different actions and implements are used. The former has sago-growing areas in coastal regions, while in Indonesia sago growing can be easily seen in Irian Jaya, Ambon, Sulawesi and Kalimantan. The results indicate some differences in techniques depending on the manner of crushing piths and the method and vessels used in washing sago piths. These differences were categorized into three types; New Guinea, Malay and Intermediate (Sulawesi) Types. These differences result from farmers' use of sago starch, either for self-consumption, selling at local markets, or in the international starch markets. On the whole, sago palm as a food source still has a great influence on the lifestyle of rural people in the areas surveyed.

**Key words:** Asian local regions, extraction methods, Pacific local regions, sago cultural zones, sago starch.

## アジア、大洋州地域におけるサゴヤシの澱粉抽出技術の比較研究

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サゴヤシはアジアや太平洋諸島のローカル地域では依然として重要な農作物として位置づけられており、根栽農耕文化圏における特徴あるサゴ農業を形成している。これらの地域におけるサゴヤシは人々の生活に密着しており、主食としての役割が重要であるが地域によって所有、消費は異なる。この農業でサゴ澱粉の加工抽出技術は地域において伝統的にそれぞれの形態を示している。本研究はこの技術の地域的な違いに着目してパプアニューギニア (PNG) とインドネシアを中心に現地調査を行い、またマレーシア等の地域については、文献、写真等の情報から技術の分布の違いを調べた。その結果、澱粉抽出技術の中で重要となるのは、収穫対象サゴヤシの伐採、サゴヤシの切り出し(ログ)、髓の粉碎、粉碎髓からの澱粉抽出の4段階である。この過程のうち、髓の粉碎技術とこの髓からの澱粉抽出方法(水洗い)に地域的な違いを見つけた。PNGは髓粉碎に斧型手道具を使用し、抽出は手で洗う装置を使用する。一方、インドネシアのカリマンタン、マレーシアにかけて、髓粉碎はおろし金型道具により、抽出は足で行う装置によるという違いが確認された。また、インドネシアのスラウェシ島はこれらの地域の間地点に当たり、それぞれの技術が混在するが、南東スラウェシでは粉碎は斧型、抽出は足型という混合型となっている。PNGは伝統的にサゴは自給用主食であり、ローカル市場までの移動がほとんどであるのに対し、マレーシアでは澱粉商品としての位置づけが強くなっている。そして、

スラウェシでは主食と商品の両方の役目を果たしていることが確認できた。このことから、この技術の違いは文化的な違いも考慮する必要があるが、自給中心か商品化かというサゴの用途による違いが大きな要因であると想定され、おろし金型粉碎、足型抽出はより商品化への用途に移った形態と考える。

キーワード アジアのサゴ, サゴ澱粉, サゴ文化圏, 大洋州のサゴ, 抽出方法,

## 1. Introduction

The present status quo shows that sago is still an important agricultural crop in especially three countries, Indonesia, Malaysia, and Papua New Guinea. In a sharp contrast, the Philippines and Vanuatu view the sago palm as more or less an “emergency crop” in times of food shortages in the wake of natural calamities, or for building materials, using the leaves as thatch for roofing (*cf.* Josue and Okazaki, 2001; Dowe 2001). Sago agriculture closely associates with root vegetable zones. As it stands, sago culture plays a leading role in the cultures of these areas concerned. For instance, Barkin (1998) concurs that “for sago to have been a genuine factor in the pre-historical life of the Penan, they must have (a) had the knowledge and technology needed to exploit it and (b) been able to do so efficiently enough to have it made worthwhile.” In their studies of the East Sepik Province in Papua New Guinea, Shimoda and Power (1990) investigated sago forestry by scientific observation and Ohtsuka (1983) studied sago eaters in Western Province. This study investigates some local areas in the Pacific Island country of Papua New Guinea, and the Southeast Asian country of Indonesia. The former has sago-growing areas in coastal regions, while in the latter; they can be easily seen in Irian Jaya, Ambon, Sulawesi and Kalimantan. This paper also discusses the reasons for the differences in the technology used by the different geographical areas and concludes that the technology used for extracting sago starch is intricately linked and adapted to suit local conditions.

## 2. Materials and Methods

Some Asian and Pacific local regions were investigated using field surveys; in which time questionnaire surveys were administered, so as to elicit responses. Data was then collected and analyzed for

this study. Other sources of reference and pertinent information were sourced from pictures and other sago palm-related research works. The period of the survey for the Indonesian case was from September 21–23, 1993 Nishimura, *et al.* (1994), while the Papua New Guinean case was from December 4–6, 2000 (Laufa 2001). The Papua New Guinean and Indonesian cases provide some scope for analytical purposes, however, some reference, for comparative purposes, has been extended to the Malaysian experience, which then lends empirical support to the ontological apparent regional cultural differences within these sago cultural zones. For the Papua New Guinean case, the situation of two villages, namely Keke/Tapala and Heatoare in East Kerema, Malalaua District of Gulf Province, were analyzed, while for the Indonesian case, seven villages in Southeast Sulawesi were taken up for the study. They are: Innebengi, Horodopi, Tinondo and Waitombo in Moweve District (Regency); Simbune, Tawainalu and Rate-rate in the Rate-rate District.

## 3. Results and Discussion

### Overview of Sago’s role as a staple food crop in the Papua New Guinean and Indonesian Cases

A backdrop of the Papua New Guinean and the Indonesian cases may provide a useful context for examining the current status quo of sago palm within the Asian and Pacific local regions *per se*. For the Papua New Guinean case, sago, a staple food crop, grows abundantly in Gulf Province. Commercializing sago on a grand scale is gradually gathering momentum after the first *National Sago Conference* of October 1999 held in Lae, Morobe Province (Laufa 2001). Likewise, the Indonesian case echoes similar sentiments as compared to the Papua New Guinean case. Here sago (*Metroxylon sp.*) plays an important role in Southeast Sulawesi societies, especially for the Tolakinese due to its role as a staple food. Ac-

According to the study of Nishimura *et al.* (1994), they identified two main types of sago growing in Southeast Sulawesi. They are: (1) "Ruggumanu" (*Metroxylon rumphii* Mart.), (2) "Roe" (*Metroxylon sagu* Rottb.). Moreover, besides sago, upland rice and maize are also important staple foods in Southeast Sulawesi. From this consumption pattern, it can be argued that the diversification of consumption in Southeast Sulawesi Province is quite feasible, if shortage of upland rice could be complemented by lowland sago palm, depending on the annual rainfall distribution in this area. Accordingly, it was concluded that the production center of sago and upland rice should be preserved in order to support the diversification of consumption in Southeast Sulawesi Province (Nishimura *et al.*, 1994). In addition, sago palm is a staple food crop for Maluku and Irian Jaya; meanwhile, rice is the staple food crop of Malaysia.

**Sago Palm Starch Extraction Methods of the Papua New Guinean and Indonesian cases: Exploring the Similarities and Differences**

Extraction of sago palm starch in Papua New Guinea and the Indonesian cases show similar processes, except that different actions and implements are used. Notably, four main steps are usually required for extracting sago starch. They are: (1) harvesting mature sago palm; (2) cutting/splitting into partitioned logs of one meter or thereabouts; (3) pounding/crushing of sago pith; and (4) washing of sago piths for starch extraction. A closer examination of the four steps stated herein may reveal the apparent differences and similarities within these sago cultural zones.

#### (1) Harvesting mature sago palms

Harvesting of mature sago palms is solely determined by the number of sago palms owned by a farmer in each of the villages surveyed in Indonesia and Papua New Guinea. Land tenure arrangements, to a certain extent, do dictate the harvesting of sago palms in these two countries, depending on how and where the sago palms are cultivated on a particular parcel of land. For the Papua New Guinean case, ownership through heritage is quite common, while the Indonesian case has heritage and other commonly agreed users' rights. Table 1 shows the relative aver-

**Table 1** Average Ownership of Sago Palms per Local Region

Country	District	No. of farmers	Sago palms per farmer
Indonesia	Rate-rate	9	276.6
Indonesia	Moweve	27	44.7
PNG	Malalaua	19	69.1

Source: These responses were collated from the questionnaire surveys.

**Table 2** Average of Sago Palms cut and processed per annum

Country	District	No. of farmers	Sago palms per farmer
Indonesia	Rate-rate	9	20.3
Indonesia	Moweve	27	8.8
PNG	Malalaua	19	45.8

Source: These responses were collated from the questionnaire surveys.

age for Rate-rate and Moweve districts in Indonesia and Malalaua District in Papua New Guinea, as per the survey results indicated here for the two sago cultural zones. As can be gauged from Table 2, Rate-rate has very few farmers and the number of sago palms per farmer is exceptionally high, which confirms that Rate-rate's use of sago starch is more commercially oriented. While Moweve and Malalaua districts reflect that both practice some commercial oriented purposes as well as self-consumption in this regard.

#### (2) Cutting and Splitting of Sago Palms

The cutting and splitting of sago is manually performed using steel axe for both the Indonesian and Papua New Guinean contexts. After gauging that the sago is ready for harvesting, cutting proceeds. Table 2 below gives a rough estimate of the average number of sago palms cut and processed per annum for aforementioned districts in Indonesia and Papua New Guinea respectively.

After cutting down the sago palm, the branches and the top are cleared, in preparation for splitting the stem into logs. From the Tolakinese context, the cutting of sago palm is referred to as "mondue", while the process of splitting the sago stems to prepare



Photo. 1 Sago pith crushing by a hatchet (PNG)



Photo. 2 Sago pith crushing by a hatchet (Southeast Sulawesi)

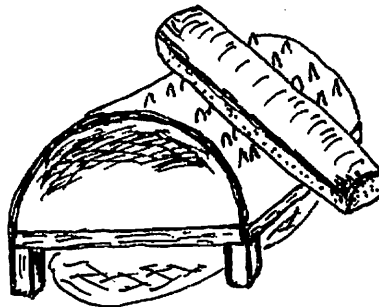
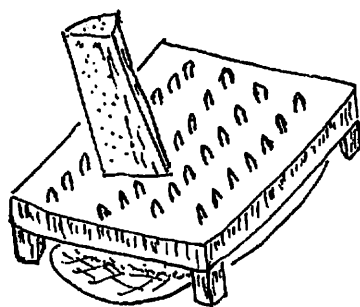


Fig. 1 Sago pith crushing by grating (Malaysia and Sulawesi)

logs is called "mowota". The latter's case in the cutting and splitting of palms occurs within the vicinity of the felling place, which could be moved to different locations depending on the availability of water sources for washing and filtering in due course. Table 2 again illustrates the scenario expressed in the situation explained in Table 1. Moreover, the task of sago log preparation for the Papua New Guinean case may not be necessary, as self-consumption as well as limited scope for marketing and distribution at the local markets renders it inappropriate to further prepare the logs, which is normally undertaken

for commercialization purposes, as is seen in Malaysia (Sato *et al.* 1981; Ohto *et al.* 1983).

### (3) Pounding/crushing of sago pith

The pounding/crushing of sago piths are carried out using a traditional tool called "saku" for the Indonesian case, while "mowora" is used for the Papua New Guinean case. Although different names are used for this traditional tool, the tool appears to have somewhat similar structures, which is driven into the peeled sago trunk to crush the piths. In the Tolakinese language, this process is called "sumaku". For the Indonesian case, there are two ways to ex-

tract sago piths, of which the first was pointed out, while the other method applied is through the use of a machine to crush the piths for washing. Though the use of mechanized extraction of sago piths appears to be gaining currency in Southeast Sulawesi villages, hatchets are still commonly used depending on the purpose of starch use. Photo 1 shows sago pith crushing by using a hatchet in Malalaua District of Gulf Province, Papua New Guinea; likewise, Photo 2 shows the application of the same method in Kendari District of Southeast Sulawesi Province, Indonesia.

Moreover, Fig. 1 below illustrates sago pith crushing by grating. The tool is made of wood attached with iron nail in Malaysia as well as in Sulawesi.

#### (4) Washing of sago piths

Washing of sago piths is relatively easier as compared to other preceding tasks; however, the only noted difference from the Papua New Guinean and Indonesian case is readily seen from their *modus oper-*

*andi* with respect to the particular areas surveyed. The Malalaua District area in Papua New Guinea and in some parts of Irian Jaya Province of Indonesia, for instance, Sorong, employ the use of hands to do the washing of starch (see photos 3 and 4 respectively).

In a sharp contrast Moweve and Rate-rate Districts in Southeast Sulawesi Province as well as in West Kalimantan use especially feet to squeeze out the starch, which is quite common (see photos 5 and 6 respectively), though the use of hands in some areas within Southeast Sulawesi Province is also being practiced. The use of hands in washing sago piths is also quite common in Papua New Guinea. There could be some exceptions to this method, as is indicated in a study by Busse *et al.* (1993). However, the feet method as observed in their study is not so common throughout sago growing societies in Papua New Guinea.

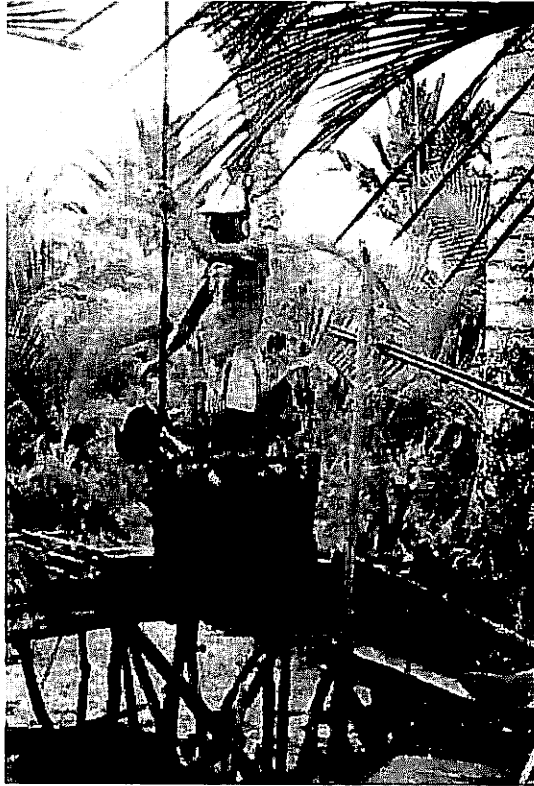
Culturally speaking, in most societies in Papua New Guinea, women by established mores, are not allowed to step over food in the eyes of men. In the light of sago washing methods, it could well be argued whether this is a gender-based phenomenon or this is based on cultural norms and beliefs of a certain area, which makes it interesting formulating views on the geographic distribution of sago pith washing, either by hands or feet. Fig. 2 attempts to illustrate the geographic distribution of sago starch washing



Photo. 3 Sago starch washing by hands (PNG)



Photo. 4 Sago starch washing by hands (Sorong)



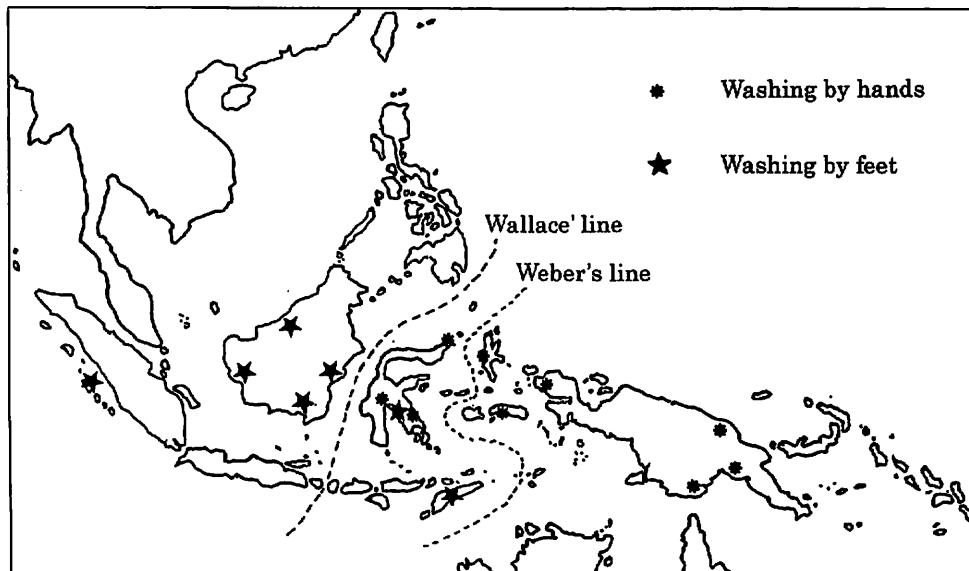
**Photo. 5** Sago starch washing by feet  
(Southeast Sulawesi)



**Photo. 6** Sago starch washing by feet  
(West Kalimantan)

methods in Southeast Asian and Pacific regions according to our study.

On the whole, the Malalaua people of Gulf Province use the "feia" as a storing vessel for collecting washed sago starch, while the Indonesian and Malaysian cases use a partially mechanized system for collecting sago starch. The current status quo clearly indicates that the Papua New Guinean case is still traditionally oriented; meanwhile, the Indonesian case shows that though some traditional use is maintained, there is an indication that it is following the path Malaysia has taken to commercialize its sago palm as



**Fig. 2** Distribution of sago starch washing methods in Southeast Asia and Pacific regions

an alternative starch for both its domestic and international starch markets.

**Classification of Sago Cultural Zones into three distinctive types based on Technological Aspects and the Purpose of Sago Palm Starch use**

According to the study by Nishimura and Laufa (2001), they have attempted to classify these sago cultural zones into three distinctive types with respect to sago processing within the Asian and Pacific local regions namely: (1) New Guinea-type, (2) Malay-type and (3) Intermediate-type. These three classified types are based on the starch extraction methods with reference to the manner and technology used in sago pith crushing and sago pith washing thereafter to collect the starch as well as the purpose of starch use and do not apply to other uses of the sago palm as a plant.

**1. The New Guinea-type:**

The "New Guinea-type" has two distinctive characteristics. Firstly, the starch extracted is mainly for self-consumption; a staple food crop for most coastal regions on the New Guinea island. Secondly, the starch normally extracted is not so much, as compared to that of Malaysia, which is determined by the types of vessels used to collect starch. The Papua New Guinean case uses a sago-plaited material to collect the sago starch. In addition, hatchets are still being used in the Papua New Guinean context for extracting piths, which are washed with water using mainly hands to obtain sago starch.

**2. The Malay-type:**

The "Malay-type" has the following salient features, in which sago starch extracted and processed here is more commercially oriented; hence, it is more of a cash crop than a staple food crop. At any rate, the amount of the starch collected is quite large compared to the "New Guinea-type". Because of its commercial purposes, the sago logs are prepared so as to extract as much starch as possible. Grating, which has been developed for mechanization purposes, is used here to crush and extract sago starch, unlike the "New Guinea-type", which uses hatchet for the most part. The washing of sago piths for the "Malay-type" utilizes stepping by the feet to squeeze out the starch, while in a sharp contrast, the "New Guinea-

type" employs mainly the use of hands, as was explained above.

**3. The Intermediate-type:**

The "Intermediate-type" epitomizes the mixed technologies adopted and adapted for sago pith extraction as well as for washing so as to collect starch. The sago starch used in Sulawesi is mostly for self-consumption and sometimes for commercial purposes too. Similar to the Papua New Guinean case, Sulawesi sago farmers also use hatchets to draw sago piths, which are then washed and filtered to collect the starch; however, in some parts of Sulawesi, grating is used for sago piths extraction. Moreover, during the washing phase, stepping by using one's feet to extract starch from the sago piths, which is similar to the "Malay-type" in Borneo, Malaysia is quite evident for the "Intermediate-type". In the final analysis, the "Intermediate-type", as the name suggests, applies to the Sulawesi case, which shows an intermediary alignment in adopting two mixed methods between the "New Guinea-type" (Papua New Guinea) and the "Malay-type" (Malaysia) with regards to its starch extraction methods as well as purpose of sago starch use.

With these findings and classifications made herein, it could therefore be hypothesized that the purpose of sago starch use is concomitant with the inherent cultural norms and beliefs in a sago growing society; to some extent, it does determine the application of its appropriate technology; either manually or through machinery, where appropriate and applicable. Table 3 below provides the summary of the classified types done by Nishimura and Laufa (2001).

**The "Centre of diversity" of Sago Palm (*Metroxylon sagu* Rottb.) Hypothesis Debate Revisited**

The centre of diversity thesis of sago palm has drawn much of its strength and character from its nature as being part and parcel of the rainforest; the connotations associated with sago palm's "wildness" (Stanton 1993). Likewise, Flach (1997) refutes the claim by Becarri (1918) that the centre of diversity of the sago palm is the Moluccan Islands in Indonesia by arguing that given; in Flach's (1983) estimate of 2.2 million hectares found on the Island of New

**Table 3** Summary of Classification of Sago Cultural Zones

Classified Types	Area (Country)	Purpose of starch use	Technology used for sago piths extraction	Technology used for sago piths washing
1. Malay-type	Sarawak (Malaysia)	Commercially-oriented for domestic and international market	Grating <sup>a</sup>	use of feet
2. Intermediate-type	Sulawesi (Indonesia)	Commercial self-consumption	Grating & hatchets	use of feet & hands
3. New Guinea-type	Malalaua (PNG) <sup>b</sup>	Mainly for self-consumption with exceptions for sale at local markets	hatchets	use of hands <sup>c</sup>

## Notes:

<sup>a</sup> The Malaysian case is now heading towards automated machinery.

<sup>b</sup> PNG referring to Papua New Guinea.

<sup>c</sup> The use of hands here is only representative of the Malalaua case and is not inclusive of other places within Gulf Province or other provinces within Papua New Guinea (op.cit. Busse *et al.* 1993: 46–7).

Guinea alone, confirms that New Guinea Island is the centre of diversity. The authors also support this view on the basis that sago palm is a native crop of New Guinea Island because it is still very much a staple food crop, especially for the Gulf people, though much of it is gathered from wild stands in the swamps (*cf.* Vasey 1985). This study is based on the above theories, which trace the origin of the sago palm's loci to the New Guinea Island.

### Conclusion

The study has investigated different technology use in an extraction of sago starch in the Southeast Asia and the Pacific Local Region. According to the field survey, information from researchers and references and report from those regions, the study identified three areas: namely, New Guinea area, Sulawesi area and Malaysia area based on two factors. They are: (1) manner of crushing sago piths and (2) the method and vessels used in washing sago piths so as to extract starch therein. This technical difference can be caused by the purposes of starch use in Sulawesi mediate between the New Guinea Island and Malaysia that self-consumption, selling for the business or both combinations. This background is also related with regional and cultural differences in accordance with biogeographical line highlighted in

the works of Whitten *et al.* (1987) with reference to the Wallace line and Weber line as a borderline area for ecological studies. It is necessary that further study be carried out to investigate more detailed facts.

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