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Measuring Sago Starch Productivity and Income of the Moveave-Toaripis of Malalaua area, Papua New Guinea

Terence Miro LAUFA

Graduate School of International Development (GSID), Nagoya University, Furo-cho, Chikusa-ku,Nagoya-shi, Aichi-ken, 464-8601 Japan

Abstract The empirical results of 51 surveyed sago farmer households in three villages in sago using agrarian societies (SUAS), Keke/Tapala, Heatoare and Savaiviri in Malalaua District of Gulf Province, Papua New Guinea are reported in this study. Interactive intimacy with this staple food crop amongst the three villages, socio-culturally referred to as the "Moveave-Toaripis", has not waned, and still continues to play a pivotal role in defining the adaptive and beneficial role of the interplay between humankind, a plant genetic resource and culture. From the traditional (micro-scale) sago starch processing point of view, it was established that about 11.33 bags of sago starch are processed per bole of sago stand for either self-consumption within a sago farmer household level or for sale at local markets, for example, in Malalaua government station, or even as far as in Port Moresby city. The sale and self-consumption ratio was worked out to be around 7.25:2.75, which alludes to the probability that from all sago starch processing in these sago using agrarian societies (SUAS), 72.5% of the total output of sago starch is sold at the market, while sago farmer households within Malalaua area consume the remaining 27.5%. Therefore, the annual rural incomes derived from sale of sago starch at local markets for SUAS are based on these sago starch productivity indexes.

Key words: Malalaua, Papua New Guinea, sago palm, sago starch productivity, sago using agrarian societies (SUAS), staple food

パプアニューギニア，マララウア地区，Moveave-Toaripis地域におけるサゴ澱粉生産とそれによる現金収入

Terence Miro LAUFA

名古屋大学大学院国際開発研究科　〒464-8601　名古屋市千種区不老町

要旨　パプアニューギニア，ガルフ州，マララウア地区内のサゴ利用地帯の3つの村落，Keke/Tapala, Heatoare, Savaiviriで，51世帯からサゴヤシの生産状況についての調査を行った．3つの村落は社会文化的にMoveave-Toaripis地域と呼ばれるが，ここではサゴヤシは主要な食糧として人々と深い結びつきを保っており，人間と植物資源・文化との関係において重要な役割を果たし続けている．伝統的な手法によると，1本のサゴヤシの幹から自家消費用と換金用に約11.33袋のサゴ澱粉がとれることがわかった．換金用にはマララウア地区の中心地や首都のポートモレスビーのマーケットで売られる．換金用と自家消費用の割合は約7.25対2.75であり，このサゴ利用地帯では，総生産量の約72.5パーセントがマーケットで売却され，約27.5パーセントが自家消費されることがわかった．これにより，サゴを売却することによって得られる現金収入が推定できることがわかった．

キーワード　サゴ澱粉生産，サゴヤシ，サゴ利用地帯，主食，パプアニューギニア，マララウア

Introduction

Sago using agrarian societies (SUAS) are collectively conceptualized as an attributive concept that supports the view that where sago palms grow, especially in the rural agrarian localities in Pacific Islands and Southeast Asia such as those in Papua New Guinea, Vanuatu, Indonesia, Malaysia, Philippines, among others, the indigenous people have established an interactive intimacy with sago palm, utilizing it as either a food or material source (Laufa 2004). Ethnological studies of the sago palm have been well documented and are richly abound in the literature, in which many researchers have attempted to explain the adaptive and beneficial role of the sago palm in SUAS. Four main perspectives are discernibly associated with these ethnological studies, of which the conceptual and underlying assumptions are sometimes overlapping each other. They are poverty-focused studies; nutritional-status focused studies; gender-focused studies and socio-economic studies. These studies are more or less thematic and development-related studies, owing to the thematic nature and intellectual quests for promoting socio-economic development in these relatively underdeveloped SUAS studied (Laufa 2004).

Viewing it from the Papua New Guinean context, a cross-section of these ethnological studies can be reviewed and analysed in the works of some of these researchers, who focused on these ethnic groups and localities, for instance, on the Sanio-Hiowe of the East Sepik Province (Townsend 1969, 1974); on the Koravake of the Purari River delta of Gulf Province (Ulijaszek 1982, 1995, 2001, 2002); on the Oriomo Papuans of the Western Province (Ohtsuka 1977, 1983); on the Siuhamason, a Kubo-speaking people of Western Province (Suda 1995); on the Arapesh of the Abelam area, East Sepik Province (Toyoda 1995, 2001); on the Kukipi people of Gulf Province (Morauta 1982); on the people of Lake Kutubu and Kikori of Southern Highlands and Gulf Provinces respectively (Busse et al., 1993). Other ethnological studies done elsewhere, for instance, in Malaysia, can be seen in the works on the Melanaus of Sarawak (Morris 1953), on the floodplain dwellers of Sungei Batu Pahat, West Malaysia (Tan 1983) and on the Penan foragers of Sarawak (e.g. Brosius 1991; Barkin 1998), among others. Based on some of these ethnological studies, the most commonly captured theme, let alone a general consensus reached, is that sago not only contributes to diets but also makes an important contribution to the culture as well (Townsend 1982).

Against that ethnological setting painted, this study devotedly pays specific attention on measuring sago starch productivity and its associated income accruing to the Moveave-Toaripis in Malalaua area of Papua New Guinea, which follows on from a previous study on their adaptability to sago starch utilization, bordering on the general outlook on the ownership structure of sago owning clans, viewed in light of the accompanied social changes in the area (Moraes-Gorecki 1983). The socio-cultural study by Moraes-Gorecki (1983) was mainly focused on determining acculturation influences such as education and the cash economy on the Moveave-Toaripi people and how this was affecting the social structures with respect to beliefs and customs amongst sago owing clans.

Moraes-Gorecki's study was undertaken and analyzed during a period of time when there was no major infrastructure project in Malalaua area But recently, the Bereina-Malalaua Highway road (1996-2000) was constructed with the finance through a yen loan and Government of Papua New Guinea (Laufa 1999, 2004).

The present study surveyed SUAS with special reference to three villages, namely: Heatoare, Keke/Tapala and Savaiviri and reports issues pertinent with how sago production and utilization may have been altered after provision of a major road infrastructure in the area, of which half of the entire 80.7 km of road (see Fig. 1) passes through what was once a low-lying waterlogged marshy peat soil between Apanaipi in Bereina District, in Central

Province and villages in Malalaua District of Gulf Province (Laufa 1999, 2004). The criteria used for selecting the three villages were based on two principal factors, namely: (1) proximity of the three villages to the newly-built Bereina-Malalaua Road and (2) more importantly, these villages are the three main sago-producing villages in Malalaua area and have over the years consistently supplied dry sago starch to coastal villages such as Kukipi, Hamuhamu and Lelefiru (see Map). Past sago production levels were quite low because commuting by river transport to Iokea in the Moripi census division and by road from there to Port Moresby, made it a daunting task, considering the travelling time and costs involved in selling the dried sago starch in Port Moresby then. The Bereina-Malalaua road now directly links SUAS in Malalaua District with Port Moresby and has increased the frequency of sago farmers' trips to Port Moresby to sell their sago starch, unlike the situation before without the road. Therefore, it would be quite an interesting case to observe how the populace in SUAS in Malalaua area are gradually moving from traditional (micro-scale) processing to a perhaps more commercially-oriented sago starch production in the passage of time, especially viewed it from the post-road period (Laufa 2001, 2004).

Materials and Methods

A. Surveyed Study sites

Data for this study were obtained from 51 sago farmer households from three villages, namely, Heatoare, Keke/Tapala, and Savaiviri, which are situated within close proximity to the Taure and Lakekamu River basins in Toaripi census division of Malalaua District, Gulf Province and possess absolute abundance of sago palms in semi-wild condition. The surveyed study sites cover about 15,000 ha of the total land area of 62,500 ha of the Toaripi census division (Fig. 1). The demographic details of the three villages are presented in Table 1. Of the randomly selected 51 sago farmers interviewed, 7 were interviewed in Heatoare; 24 in Keke/Tapala and 20 in Savaiviri villages respectively. Of the population 51 observed cases, let sample (I) denote 19 cases collected in 2000 and let sample (II) denote 32 cases collected in 2002. Semi-structured interviews and questionnaires administered to sago farmers in the Malalaua area were undertaken through two field surveys in 2000 and 2002 respectively and specifically focused on three parameters: (1) sago starch production situation in SUAS; (2) manhours and productivity in sago making process in SUAS and (3) income measurement on sago starch in SUAS, which is more or less, a function of parameters (1) and (2). The two socio-economic surveys undertaken in 2000 and 2002 were complemented with actual site observations, utilizing the rapid rural appraisal (RRA) method during sago making in the three villages, so as to check the validity and reliability of the data collected. The RRA is one of the extensively used social research methods, which is a useful analytical tool that employs ordinal measures to rank and classify groups of things, relative to a set criterion in the form of structured questions kept in mind before the research is actually undertaken (Stockin 1996). Rural development management specialists, sociologists, anthropologists, or social scientists, compelled by speculative thoughts and suppositions about assessing patterns of human behaviour and its interaction with its immediate surroundings use RRA method for complementing data collection efforts (Mikkelsen 1995). Therefore, this study used the procedures and principles of the RRA method to complement the questionnaire surveys in the manner consistent with social research methods and ethics of application and subsequent reporting of results.

Table 1 Basic demographic details of the research sites

Census Units (CU)	No. of households	Population as at 1990 census Male	Female	Total
Keke/Tapala	71	234	199	433
Heatoare	171	513	457	970
Savaiviri	67	191	192	383
TOTAL	**309**	**938**	**848**	**1,786**

Source: National Stataistical Office, Port Moresby.

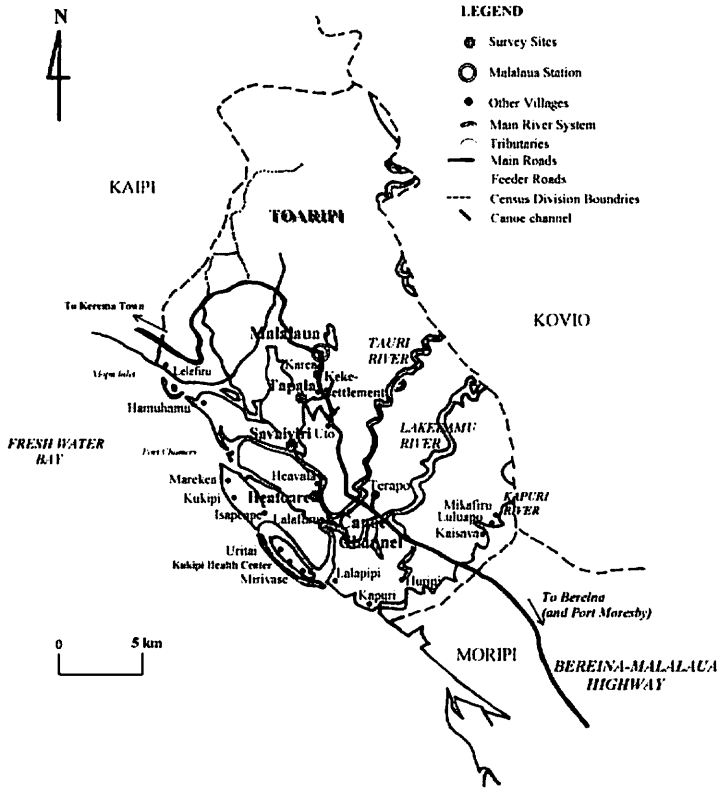

Fig.1 Map showing the research sites of sago using agrarian societies (SUAS) in Malalaua District, Gulf Province of Papua New Guinea. Source: Laufa (2004)

B. Statistical Analysis

The standard error of probability or the 95% confidence limits of the population mean (μ) of the sago palms cut and processed per annum for samples (I) and (II) is determined. The null hypothesis is that there is no significant difference between the population mean (μ) and the means of samples (I) and (II) for sago palms cut and processed per annum. To accept or reject the null hypothesis, we determine the one-tail probability at ($p<0.05$) level as well as determine the t-value of the two samples collected in 2000 and 2002 collectively.

1. Sago Starch Production (Micro-scale traditional processing) situation in SUAS

Sago starch production within the Malalaua area is characterized by micro-scale traditional processing (*cf.* Oates 1999; Oates and Hicks 2002), of which the adze-shaped traditional tool for pith extraction, "*movora*" (in Toaripi language) is still being used (e.g., Crosby 1976; Laufa 2001, 2004). The number of sago palms cut and processed for its starch per annum for the three Moveave Toaripi villages, (1) Heatoare; (2) Keke/Tapala and (3) Savaiviri was investigated so as to determine a relative yardstick for measuring sago palm biomass, which is more or less a function of labour input in the entire sago making process in these SUAS.

2. Manhours and Productivity in sago making process in SUAS

The entire duration of a sago making expedition undertaken by randomly selected sago farmers in the surveyed villages was investigated to calculate the manhours required as well as to determine the scope and nature of productivity in sago making itself. Each sago farmer was asked how long it took to undertake the entire sago making on any given day when the staple food crop was needed. Therefore, the times taken for the critical activities such as cutting/felling

of the sago palm, sago piths extraction and eventual washing of the piths to obtain starch were investigated, measured and are reported in this study. Depending on the manhours worked for sago starch processing, the relative biomass of the sago palm was determined by the number of bags of traditionally processed sago starch per sago bole/ trunk by each sago farmer per week as well as on a monthly basis.

3. Income Measurement on sago starch in SUAS

Income measurement and its subsequent analysis on the sago starch are closely related to parameters (1) and (2), of which the final sago starch productivity and income levels within SUAS in Malalaua area are determined. The ratio determined for sago starch utilization either for sale at local markets or for self-consumption at sago farmer household level, depending on the number of bags of traditionally processed sago starch, was used to determine incomes of sago farmers within SUAS in Malalaua area. Based on the number of sago palms cut and processed per month by a sago farmer, the ratio for sago starch utilization for either self-consumption within households and for sale at local markets was determined from a key question, which sought answer to the probability that if there were ten bags of sago starch at a sago farmer's disposal, how many bags were to be sold and how many were kept for self-consumption.

Results and Discussion

Overview of the sago palm's present situation in Malalaua District

Since sago forests, occurring naturally in Malalaua District, cover a wide area, it presents a peculiar difficulty and great task is required to determine the exact number of the existing sago palm stock as well as the physical area covered. Based on actual on-site observations made in the socio-economic surveys conducted by the author, it was quite evident that sago palms are concentrated in Keke/Tapala and Savaiviri villages. The latter appears to have more existing stock than the former partly because they harvest infrequently and partly because it still has abundant supply of sago palms spread over vast acres of land. Heatoare village, on the other hand, has depleted most of its sago stock, owing to frequent and "over harvesting" practices in the past. Population pressure was cited as a major problem and a challenge faced by Heatoare village during the course of the survey and this could partly explain why sago palms have declined considerably over time. Morauta (1982) notes in her study on Kukipi, a coastal Toaripi village in Malalaua District, that Kukipi was relying heavily on sago bought from inland riparian Moveave-Toaripis villages (referring to Heatoare, Savaiviri, Lalafuru and Keke/Tapala villages), which was complemented largely with trade store tinned fish/meat. This indicates that intra-district trade of sago starch was still strong even before the construction of the Bereina-Malalaua road, whereby Heatoare became the main sago seller because of its proximity to the coastal Toaripi villages. Therefore, past intensive management of sago palms for sale to coastal Toaripi villages, to someextent, explains why Heatoare village has dramatically reduced much of its sago palm stock and is processing three times less compared to the higher output produced at present by farther inland villages of Savaiviri and Keke/Tapala in Malalaua District.

Land tenure and modes of sago palm ownership

Land tenure arrangements in Gulf Province and throughout Papua New Guinea, for that matter, is determined and exercised through customary rights and obligation, which means that clans collectively own the land and not individuals. Therefore, individuals within a clan have a birthright or equal right to the clan's land. At present sago palms are not cultivated extensively as yet, owing to the natural sago forests conditions. However, through oral tradition and by way of showing clan members where their sago palms grow up until now, legitimate ownership and the right to exploit sago palms are claimed in the Malalaua area. This method of sago

palm ownership is an established more and is still being practiced amongst the three Moveave Toaripi villages, which aptly exemplifies the interactive intimacy between sago owing clans and sago as a staple food crop. (not understandable)

How sago was utilized before the road was constructed

Sago palm utilization amongst the Moveave-Toaripi villages of Heatoare, Savaiviri and Keke/Tapala was mainly for self-subsistence and for traditional barter trade with coastal Toaripi villages such as Kukipi, Hamuhamu, Lelefiru, for fish, crabs, or lobsters, which predated capitalism. Colonialism and the mercantilist era introducing western accepted norms and modes of administrative and economic practice, with particular reference to trade, played a modifying role in changing consumption behaviour of the Moveave-Toaripis. Sago starch was then traded for both fish and money from coastal Toaripi villages up until the 1980s and the trade became more cash-oriented sale of sago starch in the 1990s. As has been argued in past studies (e.g. Townsend 1982; Ulijaszek 1982, 1995, 2001, 2002), SUAS have very low levels of economic development and nutrition can be a problem, if sago starch is not supplemented with other foods, especially in regards to protein sources. In the Malalaua area, sago dishes are prepared on open fires in a hearth, using various methods; either baked in a frying pan, which is referred to as "*poi seaa*" in the Toaripi language, or wrapped and cooked in nipa palms, called "*poi potoa*", or cooked in a dish of delicacies with mixed vegetables (ripe banana, coconut cream and fish), called "*nikiriki*" (Laufa 2001). Generally speaking, sago goes well with smoked fish of different varieties such as tilapia, salmon, or even mud crabs, in the Malalaua area (Laufa 1999).

How sago was sold before the road was constructed

The sale of sago starch in the period of pre-road construction was mainly carried out on an intra-district basis wherein Toaripi coastal villages were still purchasing sago starch from inland Moveave-Toaripi villages. Only a handful of sago farmers were bringing sago starch to Port Moresby, as meandering around the river systems absorbed much time, let alone the journey from Iokea in Moripi census division, then travelling on PMV along the main Hiritano Highway resulted in paying more for transport costs for two groups of rural transport providers - the outboard motor operators and public motor vehicle (PMV) operators (Laufa 2004).

Impact of Bereina-Malalaua Road Construction on Sago Starch Utilization

The impact of the Bereina-Malalaua road construction on sago utilization amongst the Moveave-Toaripi villages of Heatoare, Keke/Tapala and Savaiviri has resulted in an increase in traditionally processed sago starch production for sale in Port Moresby City, which is correlated with low transport costs and reduction of travel time. The results of the road's impacts are discussed below, alluding to easier access, unlike the situation before the construction of the road and it is positively correlated with the fact that more sago palms are being harvested for regular sales in both rural, and increasingly for urban markets in Port Moresby City.

I. Sago palm starch production situation in SUAS

Table 2 shows the number of sago palms cut and processed by sago farmers in each village and typifies the production possibility of sago starch production of SUAS within Malalaua area in any given year. Table 3, on the other hand, shows the number of sago palms processed per month, as disaggregated from Table 2. The monthly mean number of sago palms cut and

Table 2 Number of sago palms processed per annum

Sago farmers	Village	Sago palms
7	Heatoare	150
20	Keke/Tapala	1,580
24	Savaiviri	1,342
51	TOTAL	3,072

Source: Author's sago surveys.

Table 3 Sago palms processed on a monthly basis per annum for each village

Village	Number of sago palms processed per month												
	January	February	March	April	May	June	July	August	September	October	November	December	Annual Total
Heatoare	14	10	10	7	11	14	16	16	12	15	17	8	150
Keke/Tapala	132	130	127	127	129	136	129	133	130	136	130	141	1,580
Savaiviri	117	108	101	101	110	104	114	112	113	111	122	129	1,342
Monthly total	263	248	238	235	250	254	259	261	255	262	269	278	3,072
Mean	5.1	4.8	4.6	4.6	4.9	4.9	5.0	5.1	5.0	5.2	5.2	5.4	1,042

Notes: The mean no. of sago palms per month were divided by population; N=51 cases.
Source: Elicited from the author's sago surveys.

processed stands at 4.9 palms. Implicit to this statistic is that about five sago palms are cut by a sago farmer for starch processing for either food at household level consumption or for sale at local markets. Therefore, 5-sago palms per month per sago farmer is used as an index to calculate sago farmers' monthly as well as annual incomes derived from sale of sago starch, which are extrapolated in Table 10. Considering the number of sago palms cut and traditionally processed per annum by each village as per Tables 2 and 3, the following statistics were derived for comparative purposes. Heatoare village processes about 150 sago palms per annum and has a mean of 21.4 sago palms; a standard deviation of 8.36, and standard error of the mean of 3.15. Keke/Tapala processes about 1,580 sago palms per annum; a mean of 79 sago palms, a standard deviation of 44.0 and standard error of the mean of 9.83. Finally, Savaiviri processes about 1,342 sago palms per annum; mean of 55.9 sago palms, with a standard deviation of 47.47 and standard error of the mean of 9.68.

The grouped data for the two samples taken over two different time periods for the number of sago palms cut and processed per annum are provided in Table 4. The standard error of probability or the 95% confidence limits of the population mean (μ) of the sago palms cut and processed per annum for sample (I) lies between 30.43 and 73.34. For sample (II), it lies between 48.65 and 81.70. Thus a combination of results for samples (I) and (II) indicate that (μ) lies between 48.65 and 73.34. This compares with the value of (μ) of 60.23 determined from knowledge of the whole population (N = 51). The t-values obtained for samples (I) and (II) are -0.06 and 0.01 respectively. From the table of t-distribution, the appropriate degrees of freedom (df) determined at the 0.05 significant levels are 1.734 for sample (I) and z value of 1.6 for sample (II). The results of the t table values indicate that the computed values are statistically not significant. Similarly, the t-distribution for the number of sago palms cut and processed per annum for samples (I) and (II) recorded a t-value of -0.14. This, again compared with its degree of freedom (df), is less than 1.6 at $p<0.05$ levels and is therefore statistically not significant. Therefore, the null hypothesis is not rejected.

Table 4 Statistical results showing the number of sago palms processed per annum

Parameters	Total number of sago palms	Mean number of sago palms	Standard deviation	Standard error of the mean
Sample (I)	986	51.89	31.36	7.19
Sample (II)	2,086	65.18	69.16	12.22
Population (N)	3,072	60.23	46.75	6.54

Source: From author's sago surveys.

II. Manhours and Sago Starch Productivity situation in SUAS

The main phases of sago palm processing for starch are described here beginning with selection of sago palm stands occurring in semi-cultivated or fully cultivated mode of sago palm management in SUAS

Table 5 Sago starch processing in SUAS in Malalaua area showing time taken (in hours)

	Number of sago palms processed per month									
	Cutting of sago palms		Extraction of sago piths		Kneading sago piths		Precipitating sago powder		Packing sago starch	
	Total	Mean	Total	Mean	Total	Mean	Total	Mean	Total	Mean
Sample I	27.10	1.42	76	4.00	32.5	1.71	35.75	1.88	26.16	1.37
Sample II	15.86	0.49	151	4.71	186.0	5.81	19.79	0.61	20.23	0.63
Population	42.96	0.84	227	4.45	218.5	4.28	55.54	1.08	46.39	0.90

Source: From author's sago surveys.

in Malalaua area. Before the onset of flower initiation, sago palm stands are selected at a particular location, and felled using a steel axe. The other immature sago suckers near the felled sago palm are either uprooted or pruned to clear the place for cutting off sago leaves from the felled palm, which makes it relatively easier for work to commence on pith extraction on the trunk. Depending on the number of people in a group for sago making on a given day, the tasks are normally divided among individuals, which somewhat reflects the social make up of the group as well as underlies the importance of burden sharing of tasks for much-needed food as a staple for either self-consumption at household level or for sale at local markets. Considering the phases entailed from selecting and felling of the sago palm to its eventual processing so as to obtain the much-needed starch therein, the time taken in hours is provided in Table 5, which attempts to capture the time taken from cutting of the sago palms, extraction of sago piths, kneading sago piths, precipitating sago powder and packing sago starch. The causes of the differences in samples (I) and (II) are reflective of the sample sizes, whereby sample (II) is comparatively larger than sample (I). Thus, sample (II) is more representative of the total number of observations in the study and confirmed by actual on-site observations of sago processing in the three villages (Laufa 2001, 2004). As clearly indicated in Table 5, the tedious tasks of sago piths extraction, using the traditional hand tool called the "*movora*" (*op. cit.* Laufa 2001, 2004), and kneading the extracted sago piths (washing) in the entire sago making process take more time than the other tasks between four and five hours a day. The total and average times taken in the entire sago making process are given, which are then used to calculate the required manhours per sago bole, using data from the two samples as well as from the total number of observations. Table 6, as aggregated from Table 5, shows the manhours taken in the entire sago making process in SUAS in Malalaua area. Establishing that it takes about 11.6 hours to make sago starch and using the population mean of labour input of 5.43 individuals, then the manhours required to process sago starch per bole of sago palm is about 62.98 manhours, of which the group size ultimately determines the final productivity with respect to starch output in the Malalaua area.

Table 6 Showing manhours per sago bole for traditional sago making in SUAS in Malalaua area

	Time taken (hours)		Labour (number of individuals)		Manhours (per sago bole)
	Total	Mean	Total	Mean	
Sample I	196.51	10.34	139	7.31	75.58
Sample II	393.88	12.30	138	4.31	53.01
Population	590.39	11.60	277	5.43	62.98

Source: Author's sago surveys.

Utilization and Purpose of sago starch use in Malalaua Area

Utilization and purpose of sago starch use in SUAS in Malalaua area are based on two key aspects. The traditionally processed sago starch is either for self-consumption at the household level or for sale at local markets, essentially characterizing an income-generating activity. During the sago surveys, sago farmers were asked how many bags of sago starch were produced per bole of a sago palm during sago

making session. Based on the amounts aggregated for the number of bags of sago starch per bole, sago farmers were further asked if there were ten bags at their disposal, how many would be sold at the markets and how many were kept for self-consumption. Tables 7 and 8, both provide the results showing the number of bags of sago starch per bole/trunk of sago palm as well as the utilization of sago starch showing the ratio of every 10 bags of sago starch for either sale or self-consumption respectively.

Table 7 Showing number of bags of sago per bole/trunk of sago palm

Parameters	Total	Mean
Sample (I)	225	11.84
Sample (II)	353	11.03
Population (N)	578	11.33

Source: Author's sago surveys.

Table 8 Utilization of sago starch showing ratio of every 10 bags of dry sago for either sale or self-consumption

Parameters	Sale: Self-consumption Ratio
Sample (I)	7.30 : 2.70
Sample (II)	6.96 : 3.04
Population (N)	7.25 : 2.75

Source: Author's sago surveys.

The ratios expressed for the utilisation of sago starch for every 10 bags are quantitatively expressed in Table 9. The results in Table 8 demonstrate that for every 10 bags of sago starch, about 7.25 bags are sold, while the remaining 2.75 bags are kept for household self-consumption in SUAS in Malalaua area. Taking the total of 3,072 sago palms cut and processed per annum as presented in Tables 2 and 3 respectively, and applying the sale and self-consumption ratio, the following quantity of sago starch in Malalaua area can be approximated, as is shown in Table 9. This result further suggests that many sago farmers opt to sell their sago for cash than keep it for self-consumption. We can conclude that the ratio of 7.25:2.75 (Table 8), denoting sale of traditionally processed sago starch is to self-consumption, suggests the probability for any sago making expedition, 72.5 per cent of the starch produced is for sale in local markets nearby, or as far as Port Moresby. The remaining 27.5 per cent is kept for household self-consumption within SUAS in Malalaua District.

Table 9 Utilization of sago starch showing quantity of every 10 bags for either sale or self-consumption (bags)

Mode of utilisation parameters	Approximated quantity (number of bags)	
I . Sale	(2,227.5) x 11.33	25,237.6
II . Self-consumption	(8,44.8) x 11.33	957.16
Total	(3,072) x 11.33	34,805.76

Notes: The index of 11.33 was derived from the mean number as projected in Table 7.
The total no. of sago palms to calculate the quantity palms (number of bags) was obtained from Table 2.
Source: Author's sago surveys.

III. Income Measurement and situational analysis in SUAS

The index for measuring income for SUAS as a whole and individual sago farmer was derived from the sale: self-consumption ratio (Table 8), which captures the number of bags of sago starch produced per bole (Table 7) and sold at a market venue, either locally within the village, Malalaua government station, or in Port Moresby City. Table 10 provides the results of the income analysis below, using the aggregated quantity of sago palms cut and processed per annum as is depicted (*cf.* Tables 2, 3 and 4) respectively. It should be reiterated that of the approximated total of 3,072 sago palms cut and processed in SUAS in Malalaua area, about 72.5% of the total is for sale, which ultimately contributes to rural income.

Table 10 Comparative market and income analysis on sago starch for SUAS per annum showing gross income in (PNG Kina)

Market venue (Parameters)	Quantity sold (number of bags)	Unit price (per bag of sago)	Annual gross income from sale of sago starch
		PNG Kina (K)	PNG Kina (K)
(a) Within the village	25,237.6	15.00	378,564
(b) Malalaua Station	25,237.6	20.00	504,752
(c) Port Moresby city	25,237.6	30.00	757,128

Notes: The quantity of sago bags produced per annum for sale was multiplied by unit price to determine comparative annual gross income for SUAS.
Source: Author's sago surveys.

Table 10 below shows the gross annual income derived from the sale of sago starch from SUAS in Malalaua area, depending on the market as is indicated by three market venues: (a) within the village, (b) Malalaua Government Station and (c) Port Moresby City. Judging from the comparative market and income analysis on sago starch for SUAS as is extrapolated in Table 10 below, it could possibly be argued that it is far more profitable to sell the sago starch in Port Moresby City markets, than the other two local markets per annum, given the assumption that all sago starch for sale were sold there. From individual farmer's specific assessment it was established that each sago farmer processes about five sago palms per month, and applying the sale: self-consumption ratio of 7.25:2.75, it does suggest that a sago farmer produces about 56.5 bags of sago starch and sells approximately 40.96 bags at the market per month. Therefore, using the unit price of 30 PNG Kina for a bag of sago starch sold at a market outlet in Port Moresby City, a sago farmer earns roughly 1,228.8 PNG Kina per month (Table 11). Assuming that a sago farmer supplies constantly the same amount of sago starch for sale, the annual income per sago farmer household in the surveyed SUAS in Malalaua area could fetch a gross sum of 14,745.6 PNG Kina (Table 11).

Table 11 Comparative market and income analysis on sago starch sales for sago farmers showing gross monthly and annual income (PNG Kina)

Market venue (Parameters)	Quantity sold (number of bags)	Unit price (per bag of sago)	Monthly gross income from sale	Annual gross income from sale of sago starch
		PNG Kina (K)	PNG Kina (K)	PNG Kina (K)
(a) Within the village	40.96	15.00	614.4	7,372.8
(b) Malalaua Station	40.96	20.00	819.2	9,830.4
(c) Port Moresby city	40.96	30.00	1,228.8	14,745.6

Notes: The quantity of sago bags produced per annum for sale was multiplied by unit price to determine comparative annual gross income for a sago farmer in SUAS.
Source: Author's sago surveys.

Conclusions

The production and utilization of sago starch during pre-road period was focused more on self-consumption, than selling the produce in Port Moresby City, owing to transportation problems. Therefore, the intra-district trade was more favourable then. Heatoare villageamong the Moveave-Toaripi villages provided hegemony over other sago producing villages during the earlier part of pre-road period, supplying nearby coastal Toaripi villages. The present study observes that Savaiviri and Keke/Tapala have now asserted a greater control over sago sales in the post-road period, owing to their proximity to the road for easier transporting to Port Moresby and also owing to the fact that they still have vast tracts of sago forest, occurring in natural conditions. These two factors work in their favour as contrasted with Heatoare's low output at present. The noted differences in sago starch production and utilization underscoring, though not so much on the "without-the-road" (pre-road period) situation of sago palm as opposed to the "with-the-road" (post-road period), reflects that resource pressure, in light of sago palm exploitation is still quite intensive in SUAS in the Malalaua area. Moreover, sago starch output is largely determined by application of the traditional hand tool ("*movora*") used as well as the size of the group involved in the entire sago making process and it takes about 62.98 manhours per sago bole to produce sago starch for both self-consumption and sale at markets. Because of the newly built Bereina-Malalaua road, the option of selling sago starch in Port Moresby City appears to be an attractive option, unlike the situation that preceded it.

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