

# 16 Estimating the Environmental Benefits of Sago Cultivation

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## INTRODUCTION

Palms constitute one of the oldest family of plants on earth. Several cultural groups have developed self-sufficient economies based on various palms. Examples of such groups are the Amerindians based on the moriche palm (*Mauritia flexuosa*), the Arabs of the sub-Sahara based on the date palm (*Phoenix dactylifera*), the South Indians based on the palmyra palm (*Borassus flabellifer*), the Roto Islanders of Indonesia based on the lontar palm (*Borassus sundaicus*), the Indo-Pacific islanders based on the coconut (*Cocos nucifera*), the West Africans based on the oil palm (*Elaeis guineensis*) and the Moluccans based on the sago palm (*Metroxylon sagu* Rottboll) (Tan, 1983, p.3).

Before the emergence of rice, sago (*Metroxylon sagu* Rottboll) was the main source of sustenance for the inhabitants of the Malay archipelago region. Desiccated products made from sago starch can be stored for exceptionally long periods. This dried provision enabled the early inhabitants of the Malay archipelago to travel far and wide over long distances, making the colonization of the many islands possible. Unfortunately, sago is now only a minor crop in Peninsular Malaysia, with its acreage less than 1 percent of the total land use under agriculture. The biggest sago areas in Malaysia are to be found outside the Peninsular, in the state of Sarawak. Sarawak is now the world's biggest exporter of sago, exporting annually about 25,000 to 40,000 tonnes of sago products to Peninsular Malaysia, Japan, Taiwan, Singapore and other countries.

In this paper, we first review the current status of sago in Section 2. In this age of concern about environmental degradation and pollution, the special environmental benefits of sago cultivation need to be valued and quantified. This is treated in Section 3. The unique environmental qualities of sago are enumerated in Section 4. The paper ends with Conclusions and Policy Implications in Section 5.

## PRESENT STATUS

It is estimated that the present area under sago in Sarawak is 19,720 hectares, located mainly in the Division of Sibul (Tie and Lim, 1991). The five major areas are Oya-Dalat, Mukah, Pusa-Saratok, Igan and Balingan. There are about 1.69 million hectares of peat soil in Sarawak that are considered suitable for sago cultivation. Hence, the scope for the

expansion of sago cultivation appears to be bright.

Currently, sago exports ranks as the fourth biggest agricultural revenue earner for Sarawak, after oil palm, pepper, and cocoa. Sago brings in RM23.15 million in export earnings in 1993, overtaking the export of rubber in value terms in that particular year. The exports of sago from Sarawak over the years are as shown in Table 1.

**Table 1**  
**Export Value of Sago from Sarawak (RM'000)**

<b>Year</b>	<b>Sago Export</b>	<b>Total Agricultural Export</b>	<b>Sago Export as %</b>
1970	3836	106550	3.60
1971	3352	89796	3.73
1972	2310	83070	2.78
1973	3620	159232	2.27
1974	7102	176777	4.02
1975	5305	157354	3.37
1976	6702	226160	2.96
1977	8312	266519	3.12
1978	6824	276466	2.47
1979	6940	313694	2.21
1980	8816	300455	2.93
1981	9637	218268	4.42
1982	8355	202713	4.12
1983	9677	235893	4.10
1984	10022	264403	3.79
1985	7056	313630	2.25
1986	12002	364873	3.29
1987	8724	421012	2.07
1988	13816	477059	2.90
1989	13784	445199	3.10
1990	22541	389436	5.79
1991	22852	376302	6.07
1992	31146	377737	8.25
1993	23151	383476	6.04
1994	24445	544420	4.49

Source: Agricultural Statistics of Sarawak,  
Jabatan Pertanian Negeri Sarawak, Kuching  
Figures for 1994 are provisional figures.

## Some Background Information on Sago Cultivation

Presently, sago is grown in Sarawak as a smallholder's crop. We did a random sample survey of 119 sago smallholders in Mukah District (Chew, *et al.*, 1998) in December 1996, using a prepared questionnaire. The aims of this survey were to gather information on the economics of sago production at the farm level and to determine the status of sago vis-a-vis other agricultural enterprises. Selected results of our survey are as follows.

The average size of the sago farms in our survey was found to be 5.03 ha. The average yield of palms per ha per year in our survey is 14 palms, ranging from a low of 1 palm/ha to 41 palms/ha. The average yield of 14 palms/ha is rather low compared to figures cited in the literature. For example, Kueh, *et al.* (1991) used a yield of 102 palms per ha per year in his estimation of the profitability of growing 2278 ha of sago on peat soil. Tie and Lim (1991) used a yield of 42 palms per ha per year in their paper on the prospects of sago in Sarawak. Other authors have used figures of 90 (Harun, 1995) and 70 (Department of Agriculture, Sarawak, 1996). The low yield in our survey could be because of the drop in the price of sago logs in the survey year as compared to the year before. The sago farmers were probably holding out, waiting for better prices.

Out of the 119 sago farmers interviewed, 89 or 73 percent reported having income from nonsago agricultural activities or from off-farm employment. Other agricultural activities include growing of tropical fruits and vegetables such as durian, rambutan, pineapples, bananas, chempedak, chillies, beans and so on. Livestock such as chickens and ducks are also reared. Duck rearing is especially common because of the proximity of sago holdings to canals and rivers.

Only 47 or 39 percent of our sample of farmers spend money on sago palm maintenance, which in this case involves the simple clearing of unwanted bushes and undergrowth around the sago palms. The mean cost of maintenance is only RM254.64 (US \$1.00 = RM2.50, at the time of our survey) per ha per year. *None of the sago farmers apply fertilisers on their palms.* This is consistent with findings by Tie and Lim (1991).

The sago palms are felled in about 10 to 15 years after planting, depending on the fertility of the terrain. The sago trunks are then cut into sections, each 75 cm to 90 cm long. Each sago trunk yields from 10 to 12 sections. These sago sections are tied together in the form of rafts and tugged by boats to sago factories for processing. The sago factories are invariably situated along river banks, for ease of transportation. Independent agents collect the sago sections and arrange for the transportation of the sections to the factories, for a fee. Floating the sago sections along the canals and rivers is the most common form of transportation to the factories. Lorries are also used in cases where the canals are too dry for movement by water.

At the time of our survey, the price for one sago section received by the farmers in Mukah District is about RM5.00. Transportation cost from farm to factory is about RM0.20 to RM0.30 per section. For a farmer having about 5 ha, the income received from sago is therefore about RM3,500 ( $5 \times 14 \times 50 = 3500$ ) per year, assuming 10 sections per palm. This is considered insufficient for a family of 7 household members.

We were told that a farm family needs about 10 ha of sago to live comfortably from this palm alone. Otherwise, supplementary sources of income from other agricultural activities and off-farm sources are required. Employment as part-time fisherman is also quite common among sago farmers in Mukah because of the proximity of sago growing areas to the sea and rivers.

The Land Custody and Development Authority of Sarawak (or termed PELITA, a government statutory body), has started the development of two sago plantations - one located at the boundary between Oya and Igan known as the Dalat Sago Plantation and the other located in the Mukah District known as the Mukah Sago Plantation. The Dalat Plantation is estimated to cost RM13.7 million covering an area of 1,600 ha while the Mukah Plantation is estimated to cost RM35.6 million covering an area of 20,000 ha. The underlying aim in these plantations is the application of modern, scientific agricultural technology and a large-scale institutional organisation, to exploit the cultivation of sago, that has thus far been cultivated in a very primitive and semi-wild fashion. Whether the Sarawak government's effort in this venture is going to be successful or not remains to be seen, as this is the first attempt at growing sago on a plantation scale anywhere in the world. The first harvest is only due in year 2000.

### **Sago Processing (Extraction) Factories**

In contrast to the cultivation of sago which is based on primitive, smallholding agriculture, the processing of sago sections to derive the sago starch is done using the latest extraction technology, adapted from technologies used in the extraction of starch from cassava and possibly the extraction of oil from oil palm and kernel palm. In the sago extraction process, the sago logs are first debarked, followed by maceration using a rasper. Newer types of raspers have eliminated the need for debarking. The sago chips resulting from the maceration process are then further disintegrated using a hammer mill. The starch slurry is then passed through a series of centrifugal sieves to remove the coarse fibres. Cyclone separators are then used to extract the starch which is then dried using a rotary vacuum drum drier, followed by hot air drying.

There are currently 11 modern sago processing plants in Sarawak. Each plant has fixed assets and equipment costing anywhere from 2 to 5 million Ringgits. The throughput from each of these plants ranges from 200 to 600 metric tons of dry sago flour per month. It has been claimed, justly perhaps, that the world's most efficient sago extraction industry is in Sarawak. Cost of processing is estimated to be RM9.00 per sago section, with the conversion rate of about 65 sections to produce 1 tonne sago flour (Chew *et al.*, 1998). The main cost item in sago extraction is the cost of the sago logs which accounts for 60 percent to 70 percent of the total processing cost. Fuel, utility costs, depreciation and administration takes up another 20 percent while labour cost accounts for about 10 percent. With each sago section priced at RM5.00, for example, it would cost about RM585 (65 x 9) to produce 1 tonne of sago flour. The modern sago processing plants in Sarawak are so efficient and consume sago logs in such large

quantities that the problem now is the insufficiency of logs to satisfy the demands of all the sago factories. Hence, many of the sago factories in Sarawak are now operating at undercapacity. The traditional, small-scale cottage mills, which produce a type of inferior, wet sago called "lomentak", for the local markets, are slowly being wiped out because of the competition from the high-quality, dry sago flour produced by the modern factories.

## **POTENTIAL FOR THE DEVELOPMENT OF SAGO IN SARAWAK**

Theoretically, the potential for the further expansion of sago in Sarawak appears tremendous, given the fact that there are about 1.69 million hectares of peat soil that can be cultivated with this palm. Further, it has been claimed that sago can yield up to 37 tonnes of starch/ha/year, one of the highest for starch-producing crops in the world (Jong, 1995). However, these exciting prospects must be tempered with some sobering economic facts with regard to the profitability of sago cultivation vis-a-vis oil palm cultivation.

### **Financial IRR of Sago Cultivation**

To compute the financial IRR of sago cultivation, we made use of 3 sets of data available in the literature. One set of costs and returns of sago cultivation is taken from the article by Kueh *et al.*, (1991). This set of estimates is for a sago plantation of 2278 hectares grown on deep peat. The second set of figures is from Harun (1995), who estimated the profitability of growing sago on a 10-hectare smallholding. The third set of figures is from in-house Seminar as given in the Mini-Seminar Report, compiled by the Department of Agriculture, Sarawak (1996), for a 1-hectare farm. The 3 sets of figures for sago cultivation were first standardised by using a common price of RM40 for one sago trunk. The different authors used different prices in their original reports (RM40 for Mini-Seminar Report, RM26 used by Harun and RM22 used by Kueh *et al.*, 1991). We then added in a conservative land cost of RM5,000 per ha. In the original calculations, land cost was assumed as zero, which we consider unrealistic for a financial analysis. The financial IRRs recomputed are 6.18 percent (Mini-Seminar), 0.9 percent (Harun, 1995) and 8.06 percent (Kueh *et al.*, 1991 and Chew *et al.* 1998). With such low rates of financial return compared to financial IRRs of over 20 percent for oil palm (Khera, 1976), it is not surprising therefore that much of the sago land is drained and converted to oil palm cultivation, leading to a near-total demise of the sago industry in Peninsular Malaysia.

### **Economic IRR of Sago Cultivation**

To compute the economic IRR of sago cultivation, we must first estimate the much-touted environmental benefits derived from growing sago in a peat forest environment. To do this we must estimate the Total Economic Value (TEV) of a peat swamp forest, where TEV is defined as follows (Pearce, 1990):-

$$\begin{aligned} \text{TEV} &= \text{UV} + \text{NUV} \\ &= \text{DUV} + \text{IUV} + \text{OV} + \text{EV} + \text{QOV} \end{aligned}$$

where,

TEV = total economic value;  
UV = use value;  
NUV = nonuse value;  
DUV = direct use value;  
IUV = indirect use value;  
OV = option value;  
EV = existence value;  
QOV = quasi-option value.

Direct use value for a peat swamp forest, where sago flourishes, include timber and nontimber products and tourism (recreation). The output of subsidiary products such as rattan, latex, fruits and so are measurable using market prices. Other products such as medicinal plants and yet-to-be-identified flora and fauna are impossible to quantify. Indirect values include ecological functions of the forest, such as their watershed and mineral cycling functions. Tropical forests also store carbon dioxide, which mitigates global warming. Another indirect benefit is the efficient nutrient cycling that occurs in a forest, contributing to environmental stability and resilience.

There are not many studies where TEV is quantified for a tropical forest resource. One such rare study is the work by Kumari (1995), who quantified the TEV of a peat swamp forest in Selangor. Since sago flourishes naturally in peat forests, the values obtained by Kumari (1995) can easily be modified to derive the nontangible environmental benefits obtained from growing sago.

Table 2 shows the TEV of a peat swamp forest under different management (timber exploitation) systems. TEV on a per hectare basis varies from a low of RM10,231 to high of RM12,464. These figures are net present values (NPV), using a social interest rate of 8 percent (Kumari, 1995).

For our purpose, in evaluating the economic viability of sago as an economic resource, we need to alter some of the figures in Table 2. These reasons for these modifications are:-

**Table 2**  
**Total Economic Valuation of Peat Forest Conservation Benefits (RM/ha)**

Good/Service	Unstain- able A	Unstain- able A	Sustainable B1	Sustainable B1	Sustainable B2	Sustainable B2	Sustainable B3	Sustainable B3
	20%	50%	20%	50%	20%	50%	20%	50%
	Damage	Damage	Damage	Damage	Damage	Damage	Damage	Damage
1. Timber	3448	2149	2360	1453	1750	1085	1276	804
2. Hydrological	319	319	319	319	730	730	999	999
3. Endangered spp.	378	447	436	484	469	504	494	519
4. Carbon stock	8011	7080	8677	8049	8677	8049	8677	8049
5. Rattan	35	22	177	110	194	121	214	134
6. Bamboo	157	98	157	98	78	49	78	49
7. Recreation	57	57	57	57	57	57	57	57
8. Domestic water	30	30	30	30	30	30	30	30
9. Fish	29	29	29	29	29	29	29	29
TEV (RM/ha)	12464	10231	12242	10629	12014	10654	11854	10670

Note: Taken from Kanta Kumari (1995).

A, B1, B2 and B3 refer to different timber extraction methods (see Kumari, 1995).

- (i) Unlike the case for Kumari (1995), where he evaluated the benefits derivable from different types of timber exploitation from a peat forest, we are interested in evaluating the benefits of growing sago in peat conditions, as against growing its main rival, the oil palm. However, to grow the latter, the peat forest must be drained, resulting in a drastic alteration in the natural environment of the forest.
- (ii) No one has compared the carbon sequestration ability of sago palm against that for oil palm. Given that the sago palm has many more fronds compared to sago palm and the fact that sago continuously produce suckers, the carbon fixation properties of sago should be superior to that of oil palm. Kumari (1995) had estimated that the difference in carbon sequestration between the worst peat forest exploitation method and the best exploitation method is (RM8,677 - RM7,080 = RM1,597) per hectare. The worst exploitation technique involves large-scale destruction of the trees and ground, requiring a considerable time for the forest to rebuild up its carbon sequestration property to its equilibrium level. The most benign forest exploitation method, on the other hand, involves comparatively less severe damage to forest trees and the forest floor. This difference of RM1,597 per hectare can therefore be used as the proxy measure of the difference in carbon sequestration ability between a sago plantation and an oil palm plantation. The logic is fairly simple. Oil palm cultivation involves the periodic clearing, during the planting stage, of an existing forest whereas sago cultivation involves leaving large tracts of the peat forest virtually intact in its original state. In the absence of a better estimate of the differential carbon sequestration rate between the two palms, this figure of RM1,597 would suffice and is at best a rough "guesstimate".
- (ii) Oil palm cultivation involves the drainage of the peat forest. Decomposition of the humus matter occurs as a matter of course, leading to a release of carbon dioxide to the atmosphere. Sago cultivation, on the other hand, involves minimal disturbance to the original forest floor. Kumari (1995) assumes that one hectare of peat forest has 150 Ct (carbon tonne). Each tonne of carbon is assumed to have a social value of RM14. Assuming that oil palm cultivation involves a near destruction of a peat forest, though not all the humus will completely decompose and escape into the atmosphere, a reasonable assumption would be to assume that the cultivation of oil palm in a peat forest will release 100 Ct, giving a value of  $(100 \times 14) = \text{RM}1,400$  of carbon damage.
- (iii) The environmentally-friendly benefits of sago on a per hectare basis, compared to that of oil palm, can then be summed up as follows. The difference between the carbon fixation abilities of the two palms is RM1,597, as argued above. The loss of humus, at RM1,400 for the 1st,

the 25th., the 75th., and the 100th. year, assuming a life cycle of 25 years before replanting, discounted at 8 percent social interest rate gives a net present value (NPV) of RM1,525.57. The other benefits derivable from sago cultivation, because of its minimal disturbance to the original ecological habitat of a peat forest, are: hydrological benefit estimated at RM999; endangered species estimated at RM519; recreational benefit estimated at RM57; domestic water benefit estimated at RM30; and fish benefit estimated at RM29 (all figures taken from Table 2 by Kumari, 1995)<sup>1</sup>. The sum of all the benefits give a net present value of RM4,756.57 per hectare or about RM5,000 per hectare. This figure can then be assumed to be the environmental-friendly benefits of sago cultivation as compared to oil palm cultivation. However arbitrary these figures may appear, they represent a first stab at quantifying the much-talked about, but never-quantified benefits of sago cultivation.

To compute the economic IRRs, we made the following adjustments:-

- (i) The agricultural costs (materials and labour) figures were adjusted by multiplying by a factor of 0.9, following the standard conversion factor (Veitch, 1986).
- (ii) The environmental-enhancing benefit of sago cultivation, as discussed above, was added to the income stream<sup>2</sup>.

The economic IRRs obtained are 19.18 percent (Mini-Seminar), 18.42 percent (Harun, 1995) and 17.35 percent (Kueh *et al.*, 1991)<sup>3</sup>. If the environmental benefits were not included, the economic IRRs are respectively 13.77 percent, 13.24 percent and 12.93 percent, assuming a sago log price of RM40.00 per trunk. If we were to arbitrarily increase the environmental benefits from RM5,000 to RM10,000 per hectare, the economic IRRs increases to 24.15 percent, 22.77 percent and 21.15 percent respectively for the 3 cases. Increasing the environmental benefits from RM5,000 per hectare to RM10,000 per hectare may not be unrealistic as it may appear, because the value of one

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<sup>1</sup> Taking arbitrarily the largest figures in Table 2, to reflect the worst-damage scenario.

<sup>2</sup> The inclusion of this environmental benefit was added in at the point where the income stream first turn positive from the initial, negative values, with the appropriate compounding so that the NPV is equivalent to RM5,000 as estimated. If the environmental benefit is simply added in to the initial years, resulting in a positive-negative-positive income stream, the computation of the standard IRR using the Excel or Lotus software becomes impossible.

<sup>3</sup> To give an idea as to the type of figures involved, we have include the computation of the economic IRR for the set of figures taken from Kueh *et al.* (1991) in the Appendix of this paper.

tonne of carbon reduction from the atmosphere has been estimated to range from Nordhaus's (1991) low estimate of global warming cost of US\$1.89 per tonne of carbon to alternative estimate of US\$100 per tonne of carbon (Schneider, 1992). We were using a figure of RM14.00 per carbon tonne (equivalent to about US\$5.60) in our calculations.

## **BENEFICIAL QUALITIES OF SAGO PALM REITERATED**

There are a number of characteristics of sago palm, that makes it quite a remarkable plant. First, sago is an extremely hardy plant, thriving in swampy, acidic peat soils, where few other crops survive. The palm is immune to floods, drought, fire and strong winds. Its large fibrous root system traps silt loads and removes pollutants, faecal contaminants and heavy metals. Sago forest also acts as an excellent carbon sink for carbon sequestration, thereby mitigating the greenhouse effect and global warming arising from the release of carbon dioxide into the atmosphere due to industrialization and increases in motorised vehicles (Stanton, 1991). In short, in this age of concern for the environment, *sago is the crop par excellence for sustainable agriculture.*

Second, sago palms continually produce suckers which in turn grow into adult palms. This implies that a sago holding can virtually produce palms in perpetuity. There is then no necessity for replanting. This eliminates the need for recurring expensive establishment costs, after every harvest of the adult palms.

Third, starch accumulates in the trunk of the sago palm. This starch accumulation continues until the flowering stage. Maximum starch content occurs just before the palm flowers. Sago is special among agricultural commodities in that a farmer is not forced to harvest his palms if the sago price is low. He can postpone his felling of the palms for a period of up to 3 years, until the onset of flowering, without any significant loss in starch content or quality. Thus, the sago palm acts as a form of "savings" for the farmers. The trees need only be felled when there is a sudden need for cash. Such an occasion may arise because of an impending marriage of one of the members of the family, for example. In other words, the price elasticity of supply of sago can be quite elastic, unlike the case for most agricultural products. The inelastic-supply characteristic of agricultural commodities has always been the bane of agricultural producers, resulting in poor returns during good harvests (Chew, *et al.*, 1999). This problem is especially acute for farmers in developing countries.

Fourth, sago starch has a multitude of uses. In Sarawak, sago is widely used to produce sago pearls and "tabaloi", a local biscuit delicacy. Sago pearls can be boiled, either alone or mixed with other foods, and consumed directly as a carbohydrate source. Sago is also widely used, together with rice, corn and potatoes, in the manufacture of noodles in Malaysia. The other industries that make extensive use of sago are the monosodium glutamate industry, the soft drink industry in the making of various syrups and the glue industry involved in plywood manufacture. New uses for sago include its use in the manufacture of biodegradable plastics, alcohol, ethanol and citric acid. In other

words, sago starch is a very versatile multiple-use product. The nearest substitute product for sago starch is cassava (tapioca) starch. This can be seen in Table 3, which shows the correlation matrix for the prices of various carbohydrate sources. The price of sago has the highest correlation ( $r = 0.5448$ ) with the price of tapioca, among all the starch sources. This shows, in a simplistic way, that among the different starch sources, cassava and sago are the closest substitutes to each other.

Finally, sago palm seems to have few pests or diseases. The sago beetle is one such pest which bores into the trunks of the sago palms, leaving its eggs inside. However, surprisingly, this pest is considered as a blessing in disguise, as the larvae of this sago beetle is consumed as a highly-esteemed delicacy by the local population, eaten either raw or fried. Monkeys and wild boars are the other pestilence of sago, digging up and eating the young palms during the sucker stage.

## **CONCLUSIONS AND POLICY IMPLICATIONS**

Even though, sago is considered by many plant scientists as the "starch crop of the 21st century" (Jong, 1995), the present method of cultivation of sago palm shows that it is currently grown using primitive agricultural technology. Sago is at present essentially a smallholder crop, producing low yields with minimal maintenance and zero fertilisation. Current methods of cultivation in Sarawak is not that much different from what had occurred through the millennium and what is occurring even now in the virgin jungles of Papua New Guinea.

The Sarawak government is trying to pioneer the cultivation of sago on a plantation scale, trying to tap 20th century agricultural technology and large-scale organisational structure to grow this supposedly wonder crop. However, whether the Sarawak government will be successful or not is still left to be seen. Using history as the guide, the successful cultivation of perennial crops like rubber, oil palm, cocoa and coconuts in Malaysia were all pioneered first by private entrepreneurs. Government statutory bodies followed when the technology for growing these crops on a large scale had been invented and demonstrated many times over, by the private sector. That the Sarawak government is pioneering the cultivation of sago on a plantation scale when the clonal material and plantation technology for this palm have not been established by private entrepreneurs, is therefore truly a unique and bold endeavour. And a rather risky one as well.

Given that the current estimate of the area under sago is only 19,720 hectares, mainly in the Sibul Division in Sarawak, and that there are about 1.69 million hectares of peat soil in Sarawak that can be cultivated with sago, the future for sago appears therefore to be very bright. Added to this the environmental benefits of sago, with its hardy, flood-resistant properties and its superior carbon sequestration quality and its zero requirement for fertilizers, it is not surprising that sago has been predicted to be the crop of the future.



**Table 3**  
**Correlation Matrix for Prices of Various Carbohydrate Sources**

	<b>Barley</b>	<b>Cassava</b>	<b>Maize</b>	<b>Oats</b>	<b>Potatoes</b>	<b>Sago</b>	<b>Rice</b>	<b>Sorghum</b>	<b>Wheat</b>
Barley	1.0000								
Cassava	-0.4930	1.0000							
Maize	0.8876	-0.4468	1.0000						
Oats	0.7414	-0.1545	0.7238	1.0000					
Potatoes	0.4126	0.1079	0.3220	0.6380	1.0000				
Sago	-0.2437	0.5448	0.0834	0.0792	0.2275	1.0000			
Rice	0.6318	-0.1237	0.5746	0.8461	0.4501	-0.1207	1.0000		
Sorghum	0.8022	-0.2456	0.9531	0.7477	0.3857	0.3322	0.5349	1.0000	
Wheat	0.7403	-0.1853	0.6993	0.9503	0.6739	0.1723	0.7486	0.7622	1.0000

Note: Computed from prices as given in various issues of FAO Yearbook, for the period 1984-1993, except for sago price. The prices for sago were taken from Agricultural Statistics of Sarawak, published by the Department of Agriculture, Sarawak.

However, realities on the ground tell a different story. The sago industry in Peninsular Malaysia was completely decimated by the competing demands for land and capital by the much more profitable oil palm. The financial IRR (Internal Rate of Return) for oil palm is over 20 percent (Khera, 1976), while that for sago is only around 0.9 percent to 8.06 percent, as discussed above. Given the short gestation period for oil palm of only 4 years and the current high prices for palm oil and palm kernel oil, sago is no match for oil palm in terms of financial profitability. Numerous instances have shown in Peninsular Malaysia that with adequate drainage and chemical applications, oil palm can be profitably grown on acidic peat soils. Unless steps are therefore taken to dramatically increase the profitability of sago, the sago industry in Sarawak may well follow the path to extinction, as had occurred in Peninsular Malaysia.

What can be done to increase the profitability of sago cultivation? There are 3 possibilities: (i) increase its starch yield; (ii) reduce the gestation period of sago from the present 10 to 15 years to a shorter period, say 5 years; and (iii) reduce the cost of production of sago. Yield increases and reduction in gestation period can only be achieved by research in plant selection and breeding work. The spectacular improvements in the yield of oil palm and its maturity period in Malaysia were achieved by a similar research programme, undertaken by a wide variety of governmental and private groups, in the 1900s (Hartley, 1967). Unfortunately, there are currently no private groups carrying out research on sago in Malaysia. In fact, there are now only two government centers doing research on sago. The amount of research resource devoted to sago is clearly inadequate for the monumental task of converting sago from its present semi-wild status to a modern clone, with high yields, short maturity periods and responsiveness to fertilizers. One must not forget that in the international market, sago starch competes directly with tapioca starch. Tapioca or cassava matures in about 12 months and is a heavily-researched crop, whose yields have been elevated from a dismal 6 tonne/ha to 20-30 tonne/ha. It has also been reported that super cassava clones with yields of 40 tonne/ha have been developed (Taye, 1996).

To encourage the private sector to participate in sago cultivation and sago research, the Sarawak government should consciously tipped the balance in favour of sago cultivation by reducing its cost of production. One such method would be a liberal policy of cheap peat land alienation, done openly through a competitive bidding system, for sago cultivation, with the strict proviso that only sago can be grown. This is to deter the alteration of peat areas through drainage and their cultivation with oil palm. Cheap land alienation was the policy used previously by the Colonial Government to encourage the cultivation of rubber and oil palm (Courtenay, 1971). If the cost of land is sufficiently low, sago's profitability will increase. When a sufficient "critical mass" of numbers of private entrepreneurs have entered into sago cultivation, the setting up of private research stations devoted to sago research will automatically by itself follow, as had occurred in the case for oil palm. Without such a massive push by private sector interests, it would be difficult, in fact well-near impossible, to replicate the success story of oil palm in Malaysia, for sago palm. Given the need to reduce pollution and the concern for the

environment, the widespread replacement of sago palm with oil palm would indeed be an environmental tragedy.

By quantifying the environmental benefits of sago cultivation (assuming that the social cost of 1 carbon tonne is RM14.00 and making use of selected figures used in deriving the "total economic value" of peat swamps as given in Kumari (1995)), the economic IRR of sago cultivation was estimated to lie between 17 percent to 19 percent. However, because there is currently no compensatory mechanism to pay for carbon fixation and cleansing of the atmosphere from developed countries to underdeveloped countries with tropical forests (Stavins, 1995; Schneider, 1996), the environmental benefits derived from sago cultivation cannot be monetised and therefore remains largely of theoretical interest only. Environmental groups should bring up the environmental-enhancing properties of sago cultivation in peat forest in international forums so that some form of compensatory trade-off mechanism can be established to monetise these properties. In this way, both developed and developing countries can mutually benefit.

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**Appendix**  
**Costs and Returns for Sago Planatation (2278 ha Deep Peat)**  
**(RM'000)**

Year	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
	1	2	3	4	5	6	7	8	9	10	11	12
Capital cost	2193.9	5815.4	1730.2	966.2	726	530.8	561.9	534.6	559.3	718.9	1036.3	1220.6
Variable cost												
Total cost	2193.9	5815.4	1730.2	966.2	726	530.8	561.9	534.6	559.3	718.9	1036.3	1220.6
Adjusted cost (x 0.9)	1974.51	5233.86	1557.18	869.58	653.4	477.72	505.71	481.14	503.37	647.01	932.67	1098.54
Total revenue	0	0	0	0	0	0	0	0	0	0	0	0
Total revenue adjusted from log price of RM22 to RM40	0	0	0	0	0	0	0	0	0	0	0	0
Estimated Environmental Benefit												
Revenue - adjusted cost	-1974.51	-5233.86	-1557.18	-869.58	-653.40	-477.72	-505.71	-481.14	-503.37	-647.01	-932.67	-1098.54

  

Year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
	13	14	15	16	17	18	19	20	21	22	23	24
Capital cost	1272.8											
Variable cost		2187	2030	2241.1	2107.5	2105.4	2131.5	2119	2059.5	2281.6	2551.5	2115
Total cost	1272.8	2187	2030	2241.1	2107.5	2105.4	2131.5	2119	2059.5	2281.6	2551.5	2115
Adjusted cost (x 0.9)	1145.52	1968.3	1827	2016.99	1896.75	1894.86	1918.35	1907.1	1853.55	2053.44	2296.35	1903.5
Total revenue	673.2	4488	4488	4488	4488	4488	4488	4488	4488	4488	4488	4488
Total revenue adjusted from log price of RM22 to RM40	1224	8160	8160	8160	8160	8160	8160	8160	8160	8160	8160	8160
Estimated Environmental Benefit	30976.24											
Revenue - adjusted cost	31054.72	6191.70	6333.00	6143.01	6263.25	6265.14	6241.65	6252.90	6306.45	6106.56	5863.65	6256.50

Year	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
	25	26	27	28	29	30	31	32	33	34	35	36
Capital cost												
Variable cost	2083.1	2118	2055	2255.1	2102.5	2061	2080.1	2134.5	2523.4	2405.5	2094	2037
Total cost	2083.1	2118	2055	2255.1	2102.5	2061	2080.1	2134.5	2523.4	2405.5	2094	2037
Adjusted cost (x 0.9)	1874.79	1906.2	1849.5	2029.59	1892.25	1854.9	1872.09	1921.05	2271.06	2164.95	1884.6	1833.3
Total revenue	4488	4488	4488	4488	4488	4488	4488	4488	4488	4488	4488	4488
Total revenue adjusted from log price of RM22 to RM40	8160	8160	8160	8160	8160	8160	8160	8160	8160	8160	8160	8160
Estimated Environmental Benefit												
Revenue - adjusted cost	6285.21	6253.80	6310.50	6130.41	6267.75	6305.10	6287.91	6238.95	5888.94	5995.05	6275.40	6326.70

Economic IRR = 0.1735  
NPV at 10 % = 14810.72

Source: Costs and returns taken from page 136 of article by Kueh Hong-Siong *et al.* (1991), The Feasibility of Plantation Production of Sago (*Metroxylon sagu*) on an Organic Soil in Sarawak, in Ng Thai-Tsiung, Tie Yiu-Liong, Kueh Hong-Siong (Editors) *Proceedings of the 4th. International Sago Symposium* held August 6-9, 1990 in Kuching, Sarawak (April 1991)