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Perspective on, and Future Prospects for, the Sago Industry

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The author's eye was first directed to the study of sago by Tan Sri Ong Kee Hui, who was, in the early 1970s, the Federal Minister of Research in the Malaysian Government. It was almost a casual remark in a discussion with the minister on fermentation methods for recovery of food and food enrichment processes. The minister was agreeing to opening a conference on the subject in 1972 (Stanton, 1974).

Successes and Disappointments in the Subsequent Evolution of Sago Study

The brief mention of this ancient crop and the fact that the minister in his younger days as an agricultural officer, had conducted a personal survey on sago in Sarawak, set in motion the thoughts and activities which have resulted in the current body of research and, even more importantly, the effective revival of the industry. This revival cannot be ignored. It is the "successes" aspect of the 'sago saga'.

Some sectors of the international establishment of tropical agriculture have come to recognize the worthiness of sago for a place amongst the important food crops of the 21st Century (Nagato, 1985). The disappointments arise from the fact that the recognition is far from completeness.

In his paper to the 4th International Sago Symposium, 1990 (Stanton, 1991), the author presented a deliberately provocative table, identifying not only the friends of sago but also the opponents. Hopefully, Professor Oda and Mr. Okabe, as a result of their visit to Europe in January 1992, will have an opportunity in due course to add to, and elaborate on, the items given in that list.

As the author sees the situation, action is required not only to maintain the momentum of research, but to increase the recognition of the value of the crop and of the appropriateness of the current and advocated research towards its advancement. The concept of worthiness is not easy to put across. It demands a commitment to long-term thinking as a prerequisite of the ideas by the listener. The long-term view has not been prevalent in 'western' economic thinking in the last quarter of the present century; the World Bank, for example, having come in recently for heavy criticism for devotion to 'short-termism'. This need for the promotion of long-term tropical agricultural systems research is seen by the author as one of the most important functions of the sago study group.

It is unfortunate but true that human fear, the drive to survive, seems to drive human behaviour. Thus, sacrifices are made to propitiate the powers of darkness; medical researchers unashamedly exploit, for example, the fear of death to enhance their flow of funds. Overpopulation—the mass migration of people—and the real/imagined 'greenhouse effect' have generated a whole new class of fears unimagined by our ancestors. Whilst it might be unethical to exploit these fears, nevertheless voicing them is relevant to expressing the need for sago-type research. The group may wish to query the use of the word 'imagined' in connection with sago and the greenhouse effect, but in the author's

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view the whole greenhouse scene is wrapped in uncertainty. This aura of uncertainty is a factor in forecasting about research on sago, a feature identified by the author in his paper to the 1990 Conference. Deterioration of the food supply in much of the tropical world and deterioration of the environment are realities for large sections of the population. In spite of the uncertainty, as Gribbin (1990)[1] states, there is too great a risk in doing nothing, though politicians have exploited the scientists' hesitancy in making categorical predictions.

The human population explosion may be similar to the growth of a fungus colony on a petri-dish. The colony spreads at an ever increasing rate until it reaches the edge of the petri-dish and then begins to behave strangely, going into a resting phase until better times resume. This pattern of growth in humans is consonant with that of fungi, as far as altered behaviour is concerned: it has been demonstrated experimentally in other mammals, but dormancy is one capacity not possessed by human populations.

Humans have the capacity to match resources to population. Adopting sago philosophy helps a population to buy time, to avoid the edge of the petri-dish effect, a fungal culture analogy the author used in an earlier paper on population growth in relation to food resources.

The Pattern of Sago Research

In practical terms this capacity to buy time, to avoid disaster, means not only exploiting the special properties of the sago palm, but simultaneously explain to the unenlightened what these properties are. They are listed for reference in the table below (Table 1) and define the framework for categorizing the research. The author has listed them in descending order of importance. This choice is personal and the order is subject to discussion. However, it is the vision of the set of unique properties which has sustained the author through many years of disappointments.

Referring to the items in Table 1, the most important item, 'economic acceptability' (1), is the most debatable. The reason is the long gestation period prior to the first harvest. This difficulty was recognized by Stanton and Kueh during an early survey (Stanton and Kueh, 1973)[2] and deterred international finance from promoting the new development (Stanton, 1991). That difficulty has been resolved for the first substantial new plantation in Sarawak, and possibly in the region, by Government help in the form of a soft loan to the quasi-government body at present establishing a plantation, PELITA Sdn Bhd.

As the latest financial reports confirm, and as has been observed by many recent visitors to the PELITA estate, Mukah, Sarawak, this arrangement has proved viable. The new sago is being planted according to schedule and, as predicted by Kueh and others in 1987 in their feasibility report for a large plantation (Kueh *et al.*, 1991), the growth of the new palms on the

1) Since Gribbin made his statement (Gribbin, 1990) that one should not ignore and take action against the possibility of global warming, there has been a deluge of literature and a continued diversity of opinion on the reality of the greenhouse effect and its likely consequences. Even during the period of sago-eating man in Southeast Asia, hypothesised as being for the past 40,000 years, there have been far greater rises and falls in sea level than are predicted in the worst case scenarios for the next century. The larger change has been a fall in sea level, rather than a rise. The argument submitted by the suthor in 1990 was empirically derived from the fact of the observed rate of rise in sea level in the region at the present time. At the time of writing, plans are being submitted in Geneva for a one billion pounds sterling per annum project, the Global Climate Observation System (Houghton, 1992) in Daily Telegraph (U.K.) of 29 August 1992, "£1bn plan to plot change in climate".

2) This report was pigeonholed for some time, but happily Kueh was able to continue to develop the study of sago leading to a comprehensive report in 1987 (restricted), on the basis of which the sago plantation at Mukah was developed on deep peat.

Table 1. The special properties of sago which determine the future prospects of the palm

1. *Economic Acceptability*
   This has been a matter of dispute, but recent feasibility evidence should convince the sceptical of the viability of the culture.
2. *Sustainability* of production and productivity in contrast to plantation crops such as oilpalm and tapioca.
3. *Environmental Friendliness*
   - 3. 1. Gives a forest-dimension vegetation blanket, which is permanently in place, thus providing for all the neighbourhood climatic and hydrological benefits which accrue from energy economics deep vegetation cover.
   - 3. 2. The starch from sago is potentially less energy demanding per unit product than any other starch.
   - 3. 3. *Carbon Dioxide Sink*, not only via the carbohydrate extracted, but also from the continued peat formation itself.
   - 3. 4. *Pollution Discharge*, both during growing and processing, is low.
   - 3. 5. *Environmental Clean-up* culture.
4. *Unrivalled Versatility as* a yielder of a renewable resource, in that the main output is a single compound starch.
   - 4. 1. For food and the food industry.
   - 4. 2. For heavy industry.
   - 4. 3. For fine chemical and pharmaceutical use.
5. *Robustness* as a crop, occupying an unfriendly environmental niche—tropical lowland peat and similar flood-threatened land. Surviving:
   - 5. 1. Deep and prolonged flooding.
   - 5. 2. Fluctuating salinity.
   - 5. 3. Low pH.
   - 5. 4. An anaerobic hydrosphere.
   - 5. 5. Brushwood fire (the problem of deep peat fire of the oilpalm does not apply, since sago can be kept flooded).
6. *Social Foundation* for a stable rural population in that it is the core species of an agroforestry aquaculture system, providing a diversity of all-year-round employment.

chosen area is satisfactory. Also, it is understood the financial outflow is according to budget.

This success does not mean that any economic complacency is permissible and a high research priority is for the adoption of palms with a shorter maturing period. Finding such palms may mean that the maintenance of large trunk diameter may have to be sacrificed and that new bark removal methods may be needed to avoid loss of starch.

At present, starch extraction efficiency is pathetically poor, but this is a separate research topic. However, before esoteric methods of producing new palms are adopted for the production of genetically modified 'early maturing' palms, a thorough search amongst existing genotypes should be conducted. This axiom of 'survey first the intrinsic diversity available in the population' is one which laboratory-bound molecular biologists mistakenly ignore, in the author's opinion.

Another aspect of the economic study is that of the 'energy accounting' in the production of a crop and the materials balance accounting; in the present author's view, these aspects of economic accounting are likely to become even more important in the future.

Other Topics

Many of the other topics listed in Table 1 attached have already been discussed at previous sago conferences and workshops, though 'identified' might be a more appropriate description, as the requisite information has yet to be obtained. However, under the first heading, economics, it appears little has been done on mass balancing in the processing and energy budgeting of the total operation of sago land use. The former is a familiar operation for the chemical engineer and computer programmes are available to ease the burden of the work. Professor Flach's (1990) comments on sago, as being the paragon of starch sources from the point of view of efficiency in the use of nutrients, are relevant to this accounting.

Energy budgeting is a topic which has come into prominence in recent years in relation to exposing the large energy input, in comparison with output, with cereal culture, maize in the

United States being the textbook example used by Pimentel (1980). In terms of global agricultural commodity economics there is a link between sugars, starches and oil seeds and other energy sources. By contrast, the whole growing and processing of sago appears to be energy-economical, though an accurate picture has yet to be drawn. Study of the sago energy budget would be helpful in identifying those areas of technological advance requiring attention and emphasize further the need for improvement in the means of transport of logs/sections (also relevant to item 3.2 in Table 1). Such an improvement would in turn lead to the opportunity to apply 'just in time' logistics to the supply of raw material to the factory, eliminating the existing problem of deterioration with storage. This suggestion does not imply that no work has been done on energy budgeting in the study by anthropologists of the indigenous use of sago, but the exercise for the modern commercial production is quite different.

Understanding the concept of environmental friendliness (topic 3 in Table 1) demands a full understanding of the flora and fauna of the sago swamp. The flora has been well documented since the early 1960s (Anderson, 1963)[3]. However, the information on the fauna is very scattered and incomplete. Some indication of the insect fauna may be gained by reference to the oilpalm and forestry work. The author has unearthed unpublished work on the fishes of peat swamps. Some idea may be gained of the avifauna by reference to the work of the Asian Wetlands Bureau, Kuala Lumpur, but the director, Dr. Duncan Parish, in recent discussion admitted their studies were incomplete. Further insight might come from the work of Professor Kira and colleagues of Osaka University from the MAB studies of the early 1970s and more recent WWF investigations. The conclusion is that knowledge of the fauna is very incomplete, yet it seems desirable that an integrated study should be made at this stage of development of the industrial plantations of sago. As reported at the last symposium (Gombek, 1991), outbreaks of various zoonoses have been noted and these are likely to increase if the environmental health of the plantations is disregarded.

Finally, reference is made to the topics within category 6 of Table 1. The use of the products of the plantation for local industry is already receiving attention, though with the availability of high quality starch and flour, one can envisage a rapid expansion of all the food uses, many of which have not been exploited hitherto, solely on the grounds of the poor quality of sago. The factors restricting the incorporation of more than 10–15% sago in bread manufacture in the 1960s and 1970s have now been eliminated and, with the present low cost of gluten on the world market, there appears to be now no economic or technical barrier to the incorporation of a much greater percentage of sago flour into local bread.

There has been some misunderstanding of the distinction between paper and particle board (Haryanto, 1991)[4]. In the author's view further study is needed on the production of hand-made paper from 'hampas'. The making of speciality papers has been developed to a fine art in Japan. Fibre boards from the fibrous residue are understandably uneconomic because of the large amount of synthetic resin required, but neither this impediment, nor the need to remove the starch from the 'hampas', is necessary for paper manufacture.

However, referring back to category 3.4, clean-up cultures, the author suggested in the 1990 Symposium that sago was a clean-up crop for

3) Fauna of the peat swamp. The author is grateful for information on this topic with Dr. Elizabeth Bennet (Kuching, N.Y. Zoological Society) on the mammals; Ms. Megir Gumbek (Agric. Dep., Kuching) on the invertebrates and other fauna and Ms. Josephine Pang and Francis Chai (Fisheries Dep., Kuching) on the aquatic fauna, especially the fish.

4) The proposal of the use for paper has also been made by Parida, Puan Mohd Tahir at a closed workshop, Sago Workshop '92, Sibu, Sarawak, 21 February 1992.

de-polluting water. From his experience with oilpalm and rubber effluent, he would suggest that this dual role of the palm for use in water purification and for the plantation canals for aquaculture should be considered as a feature of the diversification of the sago economy, producing valuable revenue for the local inhabitants. The infrastructure, in the form of 'closed canals', is already in place and needed for transport. All that is needed is attention to the oxygen and pH status of these canals. The author noted at a recent visit to Mukah, for example, the return of the valuable fresh-water prawn, *Macrobrachium rosenbergii*.

Discussion

Many of the features of sago systems, listed in Table 1, would require a paper in their own right to do justice to the virtues of sago on account of the particular feature cited. Others are research agenda items yet to be investigated fully. One object of this paper is to identify features of sago systems and place them on record.

The central theme of this paper rests on the hypothesis that the development of a new crop, especially one which has the potential to be an internal staple commodity in competition with others, does not follow rational lines. As in the development of fractal structures, a small deviation in development at an early stage of the evolution of the domestication of the plant, may set the expansion and spread of the domesticated plant on a diametrically different course of development.

At present the 'saga' for sago is still unfolding. The evolution of sago has two advantages. Firstly, its 'wildness' has not been lost. The diversity is still present, but, like all rainforest species and indeed all domesticated plant species, the base for studying and the opportunity for collecting from the centres of diversity is rapidly being destroyed.

Secondly, being a late-comer to domestication, the experience from the domestication of other crops may be applied. There is also the opportunity to accelerate the processes of design of the crop and rapid multiplication of elite clones, through advances in the plant sciences of tissue culture and genetic engineering, which were not available to earlier generations of plant breeders. These advances in plant science dispel economic objections to fostering the development of the crop. Nevertheless, the author retains the view that there should be a continued striving for earlier maturing sago.

Each of the other topics listed in Table 1 could be the theme of an essay in itself. The author, therefore, proposes to concentrate in this discussion on the table on the last topic, sago as the basis for a social system.

From the beginning of the 19th Century to the present time, but particularly during the industrial revolutionary periods, there has been the trend to mono-crop large-scale agricultural and horticultural productions and the shipment of the commodities from that high-energy enterprise over long distances.

Apart from an increasing awareness in the last decade of the energy cost of this type of production, we are beginning to witness an awareness of the social disruption it caused. Japanese human ecologists in particular, such as Ohtsuka (1983), have pursued long-term studies in various parts of Oceania and Southeast Asia and one may now profit from the meticulously detailed information they have gathered and apply it to formulating systems for the future.

In the traditional systems are several interacting components, the tree starches, the root and tuber starches and the upland and swamp rices. The story of how these three components have interacted over past millenia may never be known fully, but the author does not accept the view of some researchers that the demise of sago for food is inevitable. On the contrary, it is the author's view that, as modern food technology is increasingly applied to high quality sago products, it is set to be restored to its former position as a staple provider of energy foods. Further, with the present return to favour of the

concept of biodegradability in non-food materials, the former status of total use of the palm will be restored.

Elsewhere, the author has suggested how plantation sago might have other functions in the operation of the rural community such as pollution abatement, a livestock and an aquatic product industry. This again is a return to the earlier function of sago forests in providing a mixed product economy within gathering distance of a sedentary community.

There has always been an interaction, in terms of management and exploitation of the zones by local people between the upland forest, the sago swamp and the nipa and mangrove swamps, and it is heartening to see that Hisajima (1992) has revived this concept of the use of coastal zonation of vegetation, not only for product exploitation but environmental conservation and storm and flood protection practices, as set out in the recent issue of the Sago Newsletter.

It remains to be seen how far modern technology will transform the agro-forestry systems, but, if any lessons are to be learned from the current reversal of trend in developed country agriculture, the possibility exists of new systems evolving without the devastation and expensive restorative work on the coastal environment brought about through ignorance of the damaging power of climatic factors when unleashed on improperly managed land.

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