Technical Recommendations For The Establishment of A Commercial Sago Palm (Metroxylon sagu Rottb.) Plantation

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Abstract For the establishment of a commercial sago palm (Metroxylon sagu Rottb.) plantation, mineral soils and shallow peat are preferred over deep peat. Although sago palms can be cultivated on well-decomposed deep peat, extra costs have to be incurred especially for the higher nutrient requirements. Commercial sago palm plantation on raw or poorly decomposed fibric peat is costly and unlikely to be economically viable. Suitable drainage and soil water-table regulation at around 20 to 50 cm below the soil surface are important to facilitate crop maintenance and infrastructure development, as well as to promote the growth the sago palms.

An efficient transportation system needs to be established to facilitate crop maintenance and transportation of farm inputs and harvested products. This may be accomplished by the construction of road or canal at every 500 to 1000 m intervals, thereby dividing the planting areas into rectangular blocks of about 50 ha each.

To enhance their survival rate, suckers (offshoots) should be nursed. A floating raft nursery system is recommended as it offers the highest sucker survival rate and requires relatively little maintenance. Trimming of leaflets to reduce transpiration is essential especially during transplanting in dry seasons. A palm spacing of 10 m by 10 m in a square pattern may be adopted.

In the field, indigenous fern species are retained to serve as natural soil cover. Weeding along the planting rows is carried out twice a year, with fertilizers applied immediately after weeding. Sucker growths in each palm cluster are regulated stepwise, so that only one sucker is allowed to further its development in a desired interval, normally from 18 to 24 months.

The above mentioned practices were implemented at the NTFP sago palm plantation on deep peat with reasonable success. The infrastructure system has adequately facilitated the continuous operations of the plantations and the sago palms responded rather well to the various agronomic practices.

Key Words: Agronomy, Plantation establishment, Sago palm, Sago starch

Introduction

The sago palm (Metroxylon sagu Rottb.) is an environmentally friendly crop. With relatively little soil improvement, waste swamps that are unsuitable for most crops can be used for sago palm cultivation. Containing about 1000 stomata per mm² of leaf blades (Omori et al., 2000), the sago palms are highly efficient in photosynthesis. Being perpetual in life cycle, the sago palms fix CO₂ all the year round, into large quantities of carbohydrates that are converted and stored as starch in their huge stems (trunks).

With current emphases of environment protection and reduction of CO₂ emission, there is renewed interest in the production of ethanol from starch. Besides, starch is also a raw material for biodegradable plastics which may partially substitute petroleum-based plastics in the future. As such, sago starch previously deemed as a potential food source should now be considered also from a different prospective: an environmentally friendly and competitive raw material for the food and non-food industries.

The use of sago palms probably initiated from prehistoric time (Rhoads, 1977) and international trade of sago can be traced back to 1820 (Morris, 1997). Despite its long usage coupled with the extremely high starch yield and long economic life, the sago palms have not gained popularity as a commercial plantation crop. To date, most of the world’s sago is produced from smallholders employing traditional or semi-wild cultivation practices. Conventional plantation investors are unwilling to invest into sago plantation because (i) financial returns can only be expected after about eight to ten years, owing mainly to the long juvenile growth of the sago palms (ii) project financing from conventional sources like bank is yet to be available (iii) there is a general lack of understanding about the commercial potential and large-scale cultivation of the sago palm and (iv) successful commercial plantations to lead and convince investors are still lacking.

Considerations and recommendations for sago palm plantation establishment

Soil suitability

In terms of frond production rate, frond longevity, crown size, total leaf area and time to maturity, sago palms established on mineral soils are superior as compared to those established on deep peat (Table 1).
Peat is extremely poor in nutrient content (Tie and Lim, 1997; Kueh et al., 1991; Nitta et al., 1999). In a sampling site at the Batang Hari Basin in Jambi, the mineral content per hectare basis of a 540 cm peat stratum is far less than those of a 25 cm layer of alluvial clay (Furukawa, 1994). Research carried out in Sarawak (Jong, 1988) showed that sago palms on loose and poorly humified peat of greater than 3 m grew rather well in the first three years after planting. Thereafter, the growth declined and most of the palm crowns contained less than 10 living fronds. They usually possess pale and dull green leaflets with brownish/orange frond stalks. In the same area on 3 m deep peat, only about 3% of the palms attained full trunk growth after 12 years. Such a palm produced less than 30 kg of dry starch per trunk, as compared to about 200 kg in a normal healthy palm (Jong and Flach, 1995).

Tie et al. (1991) reported that 62% of the total sago producing areas in Sarawak were located on peat, with 7500 hectares on deep peat of greater than 150 cm of organic materials. They also reported that sago palms had extensive root system to tap the substrate for the required nutrients. However, it is expected that the density and growth vigor of those sago palms on deep peat, especially those of greater depth than 3 m, will be lower and poorer respectively. The low nutrient contents of deep peat are unlikely to provide sufficient nutrients needed for sustainable sago production under intensive cultivation without added nutrients.

**Soil water-table requirement**

The sago palm is a low input crop that can grow on swamps such as undrained peat (Kueh and Jong, 1993). Given a favorable starting condition, the sago palms can outdo most other plants on fresh water swamps and gradually colonize such a habitat through vegetative and generative perpetuation. Such natural sago habitats can be found in the Sepik River Basin and are referred as sago palm phragmites swamps and sago palm swamps (Haantjens, 1968). Probably because sago palms are commonly found on swamps, they are regarded as a wet land crop and subsequent cultivation by mankind was mostly carried out on wet lands.

Haantjens (1968) reported that sago palms under constantly wet conditions were stunted and only a few palm clusters were capable of forming trunks. In contrast, regular trunk and flower formations were observed in the palms at the higher part of the Sepik River Basin. Kraalingen (1983) also observed that fewer new leaves emerged when sago palms were flooded during the long rainy season. Flach (Pers. Comm.) mentioned that sago palms could be cultivated on dry lands. He reckons that naturally occurring sago palms are commonly found on swamps because most other plants fail to compete with the sago palms in the natural swamp habitat.

Over-drainage may result in water stress to the sago palms. In mineral acid-sulphate soils, over-drainage is likely to cause acid toxicity. In peat, this may result in peat subsidence and losses (Furukawa, 1994). Dissolved nutrients in the peat will also be lost during drainage. As such, drainage should be controlled and the soil surface should be protected from drying by natural or planted cover crops.

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Table 1 Comparison of sago palm growth on mineral soils (MS) and deep peat soils (DPS). Growth parameter was collected from palms after the trunk formation stage

<table>
<thead>
<tr>
<th>Growth parameter</th>
<th>Soil type</th>
<th>Reported value</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frond production rate (no/year)</td>
<td>MS</td>
<td>18-24</td>
<td>Flach and Schuiling (1989)</td>
</tr>
<tr>
<td></td>
<td>DPS</td>
<td>5.3-10.3</td>
<td>Jong and Flach (1995), Jong et al. (1995)</td>
</tr>
<tr>
<td>Frond longevity (months)</td>
<td>MS</td>
<td>&gt;15</td>
<td>Jong and Flach (1995)</td>
</tr>
<tr>
<td></td>
<td>DPS</td>
<td>9.12</td>
<td>Jong unpublished data</td>
</tr>
<tr>
<td>Total leaf surface area (m²)</td>
<td>MS</td>
<td>220</td>
<td>Jong and Flach (1995), Jong (1995)</td>
</tr>
<tr>
<td></td>
<td>DPS</td>
<td>6-9</td>
<td>Jong and Flach (1995), Yamaguchi et al. (1997)</td>
</tr>
<tr>
<td>Trunk diameter (cm)</td>
<td>MS</td>
<td>41-60</td>
<td>Mohd. Noh (1991)</td>
</tr>
</tbody>
</table>
**Infrastructure Development**

A combination of rail, road and canal can be used in a sago palm plantation. The rail is mainly used to transport inputs from wharf to the plantation camps for redistribution. A central rail system shall provide speedy transport of harvested sago logs from the plantation canals to the seaside. Within the plantation, a rectangular blocking system of 1000m by 500 m can be adopted, with a network of canals separating each planting block of 50 hectares. Simple dams can be built at appropriate places along the canals to maintain the water table at about 20-50 cm below the soil surface. The dugouts from the canals can be leveled to form a road network. Farm tractors, four-wheel drive vehicles and motorcycles can be used for transportation and supervision. During rainy season, canals may be used instead. The canals can also be used for nursery and for the transport of harvested sago logs in the future. In case of fire out-breaks, these canals shall serve as barriers to contain the spread of fire. They provide a proximate water source for fire fighting.

**Field preparation**

Only the intended planting rows are cleared, either mechanically or manually to facilitate access in subsequent lining and planting works. Felled vegetation in-between the intended planting rows are undisturbed. Land clearing by burning is forbidden and the felled vegetation is normally left to decay and return the nutrient to the soil. Cover crops are normally not planted, as the felled vegetation and the rapidly establishing fern are serving as natural cover.

In NTFP, the felled vegetations are left for about a year to enable the natural decomposition of small trunks and branches prior to planting row preparation.

**Planting material, nursery and transplanting**

Suckers are the most widely used planting material. The use of generatively derived seedlings is limited as fertile seeds are difficult to find in most sago production areas. Besides, seedlings are variable in morphology, growth vigor and suckering capabilities. It takes about three years to raise a newly germinated seedling to the size of a sucker normally used for planting.

Nursery enables the selection of healthy suckers for field planting. It greatly enhances the survival rate of transplanted suckers and increases the uniformity in palm growth. The survival rate of suckers in a nursery depends very much on the physical and physiological (maturity) conditions of the suckers received. Low survival rates and extended nursery are normally encountered if the suckers are dehydrated, pest infested or immature.

There are several methods of nursing sago suckers. These include pond nursery with or without shade and irrigation by sprinklers; raft nursery floated either by bamboo, light timber, sago frond stalks or plastic containers. If canals and rivers are available, the raft nursery is recommended as it gives the highest rate (80 % or above) of sucker survival. Little maintenance is required once the nursery raft is floated on water and nursed suckers can be extracted easily for transplanting.

A square spacing of between 8 to 10 m is suitable for the field planting of sago palms. Nursed suckers are ready for transplanting when new roots and leaves start to emerge, at about 3 month in the nursery. Before transplanting, excessive roots and fronds are appropriately trimmed to facilitate transporting and planting. For further improvement of sucker survival in the field, rough handling, delayed planting, carrying suckers by the young shoots, excessive sucker trimming, improper holing and planting (Jong and Kueh, 1995) should be avoided.

**Maintenance**

**Weeding**

Weeding is important to reduce competition for sunlight, space and nutrients in the early growth stages of the sago palms. It is carried out manually 2 to 3 times a year as row weeding. Overhead shades must be removed in row weeding. Indigenous fern species in between the planting rows are retained as natural soil covers. Chemical weeding with contact herbicides may be employed but experience from existing trial showed that there is little cost advantage as compared to manual slashing. Besides, herbicide injury to sago palms is frequent and application of herbicides is difficult during rainy and windy days.

**Sucker regulation**

Following each weeding, sucker regulation and fertilizer applications are carried out. The main purposes of sucker control are (a) to promote the growth of the mother and desired follower palms by reducing competition with other crowded suckers in each palm cluster (b) to evenly spread out the chronological development of the follower palms in each cluster for subsequent staggered harvestings.
With such a sucker control programme, a mature palm cluster is expected to consist of about 6-8 palms of different growth stages, with a time separation of 18 to 24 months between each successive growth stage.

Fertilizer application

Reports on the response of sago palms to fertilizer are scarce. Soil-applied NPK on sago palms grown on deep peat, over a 12 year period failed to produce significant increase in frond production rate, trunk girth and palm height (Kueh, 1995). Despite the rarity of fertilizer research on sago palms, the addition of nutrients is deemed essential for the optimal growth of the sago palms. The poor growth and low productivity of sago palms on deep peat (Flack, 1984; Jong, 1988, 1995; Tie et al., 1987; Yamaguchi, et al., 1997) were likely caused by multiple nutritional deficiencies, probably due to low soil nutrient reserve or poor soil conditions that hinder the uptake of nutrients by the sago palms.

Crop protection

Some potentially serious pests are termites, hispid beetle larvae, sago worms, and wild pigs (Gumbek and Jong, 1991). Recently, a yet to be identified species of leaf miner have been discovered in various regions of Indonesia (Jong, unpublished). Other minor pests include grass-hoppers, crickets, bagworms, monkeys and rats. Although serious pests and diseases have not been commonly found, inspection of pest infestation should be routinely carried out in a commercial sago palm plantation. Controls and treatments should be carried out as soon as they are detected to arrest further spread of the pests or diseases.

Research and development

To make the sago palm an attractive plantation crop, urgent research to shorten the juvenile growth is required. The creation of a fast maturing and high yielding palm is the ultimate goal to be achieved. The availability of quality planting material is anticipated to be in short supply if more plantations are to be developed. Thus, mass propagation by in vitro technique should also be intensified. Agronomic practices especially in soil management and fertilizer dosages should also be continued concurrently to accelerate palm growth and improve starch yield. Research to identify new industrial uses of the sago as well as its co-products should also be prioritized.

Discussions

Various practices like infrastructure, soil water regulation and agronomic maintenance were put into practice at a proposed 20,000-hectare sago palm plantation established on rather humified (hemic) deep peat in Riau, Indonesia. A combination of rail, road and canal system has so far adequately facilitated the overall operations of the sago palm plantation. Canal excavation on peat has proved to be relatively simple, and collapse of canal walls is insignificant. Perhaps of the regular rainfall and high ground water-table, water loss by seepage through dams is negligible.

In the 12,000 hectares of sago palms already established, symptoms of retarded growths are present but uncommon, and can be corrected with added nutrients. About three to four months after each fertilizer application, the palms flourish with greener and more lustrous fronds. Thereafter, the lustrous green leaves gradually appear dull and pale looking if fertilizers are not added in accordance with the scheduled six-month intervals. In terms of crown size and visual growth vigor, properly maintained sago palms in the plantation are comparable to those sago palms grown on mineral soils. Despite inadequate maintenance owing to financial setback in recent years, the overall palm growth is considered satisfactory although not optimal.

References


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