INFLUENCE OF INDIGENOUS SAGO-BASED AGRICULTURE ON LOCAL FOREST LANDSCAPES IN MALUKU, EAST INDONESIA

M Sasaoka[1], Y Laumonier[2] & K Sugimura[3]

[1]*Graduate School of Letters, Hokkaido University, Kita 10, Nishi 7, Kita-ku, Sappora, 060-0810, Japan; m.sasaoka@let.hokudai.ac.jp*
[2]*Centre de Coopération Internationale en Recherche Agronomique pour le Développement, BSEF-UR 105, 34398 Montpellier, Cedex 5, France*
[3]*Forestry and Forest Products Research Institute, 1 Matsunosato, Tsukuba, Ibaraki, 305-8687 Japan*

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SASAOKA M, LAUMONIER Y & SUGIMURA K. 2014. Influence of indigenous sago-based agriculture on local forest landscapes in Maluku, east Indonesia. This study assessed the influence of sago-based vegeculture (cultivation of sago and vegetatively propagated crops) in Seram, Maluku province, east Indonesia, on the local forest landscape. The land productivity of sago groves, dependence of local people on sago and size of shifting cultivation field were analysed. Field research was conducted intermittently between 2003 and 2010 in an upland community in Seram. The study found that (1) the land productivity of sago groves in the village was higher than that of upland rice fields throughout South-East Asia, (2) sago was the most important staple food in terms of energy intake and was highly valued by the local people and (3) shifting cultivation fields were very small compared with upland rice fields throughout South and South-East Asia. This type of small-scale shifting cultivation creates relatively little pressure for forest clearance, suggesting that sago-based vegeculture contributes, to some extent, to supporting the rich natural forest-dominated rural landscape in Seram.

Keywords: *Metroxylon sagu*, land productivity, shifting cultivation, forest conservation, biodiversity

SASAOKA M, LAUMONIER Y & SUGIMURA K. 2014. Kesan pertanian asli berasaskan sagu terhadap landskap hutan tempatan di Maluku, timur Indonesia. Kajian ini menilai kesan pertanian sagu dan tanaman yang dibiakkan secara vegetatif di Seram, wilayah Maluku di timur Indonesia terhadap landskap hutan tempatan. Produktiviti tanah dusun sagu, kebergantungan penduduk tempatan terhadap sagu dan saiz ladang pertanian pindah dikaji. Kerja lapangan dijalankan berjeda antara tahun 2003 dengan tahun 2010 di kalangan komuniti tanah tinggi di Seram. Kajian mendapati (1) produktiviti tanah dusun sagu di kampung lebih tinggi berbanding dengan bendang di tanah tinggi di seluruh Asia Tenggara, (2) sagu merupakan makanan ruji utama dari segi penghasilan tenaga dan ia sangat bernilai kepada penduduk tempatan dan (3) ladang pertanian pindah adalah sangat kecil berbanding dengan bendang di tanah tinggi di seluruh Asia Tenggara dan Asia Selatan. Jenis pertanian pindah kecil-kecilan ini kurang mengancam hutan. Ini mencadangkan yang pertanian sagu dan tanaman yang biak secara vegetatif menyumbang sedikit sebanyak terhadap landskap luar bandar Seram yang kaya dengan hutan asli.

INTRODUCTION

In the rich tropical forest of Indonesia, Maluku is reported to have the second largest proportion of forest cover in any province (74% in 1997) after Papua (81% in 1997) (FWI/GFW 2002). Most rural landscapes in Maluku are still dominated by rich natural forest, the exceptions being areas targeted in state-sponsored transmigration programmes, coastal lowlands deforested by commercial logging and other developed areas (e.g. plantations).

The relationship between agriculture and forest is typically competitive, a characteristic particularly pronounced in the tropics. As the expansion of agriculture tends to occur at the expense of forest, the type of agriculture practised in an area has major influence on the local forest landscape.

Sago, a starch extracted from the pith of sago palm (*Metroxylon sagu*) stems, is a very important staple food in eastern Indonesia and New Guinea (Ehara et al. 2000, Sasaoka 2006). As in other parts of eastern Indonesia in the swampy lowlands of New Guinea and Near Oceania (Nakao 2004, Ehara 2009), Moluccan indigenous agricultural practices involve sago palm cultivation and shifting cultivation whereby main crops are banana and tuber crops (sweet potato, taro, cassava), which are primarily vegetatively propagated (Ellen 1993). In this type of agriculture, known as vegeculture (Yoshida & Matthews 2002), crops are propagated through a vegetative reproduction process that generates new individuals using methods such as herbaceous cuttings, root division, layering and budding.

Nakao (2004) divided the agricultural systems of the world into four categories of basic agricultural complexes, with the indigenous agricultural systems of South-East Asia and Oceania falling into the vegeculture basic agricultural complex category. Drawing on this term, in this paper we refer to the indigenous agriculture as practised by the sago-dependent communities of Maluku as sago-based vegeculture.

Tree-based agricultural systems (agroforestry) have been receiving considerable attention because of their value in biodiversity conservation (Pandey 2002, Perfecto & Vandermeer 2008). Agroforestry systems have less biodiversity than primary forest, but they have the added function of serving as an effective buffer against deforestation and conversion of forest land to other landuses that threaten forests (Pandey 2002). Agroforestry systems are also believed to have greater potential than field crops for sequestering carbon (Montagnini & Nair 2004). This is based on the notion that incorporating trees into crop lands results in greater net aboveground and belowground carbon sequestration (Nair et al. 2009). However, Moluccan indigenous tree-based agriculture (sago-based vegeculture), as a form of agroforestry system, has received little or no attention.

In this paper, we explore this theme by investigating the impact of sago-based vegeculture on the local forest landscape in central Seram, an island in east Indonesia. We described local knowledge and techniques for sago-based vegeculture. We also examined the potential compatibility of sago-based vegeculture with rich natural forest through an analysis of the following factors: land productivity of sago groves, dependence of local people on sago for their dietary requirements and the size of shifting cultivation fields. We explored the potential of sago-based vegeculture in biodiversity conservation and carbon sequestration implications.

MATERIALS AND METHODS

Study site

Seram island is the largest island in the Moluccas (18,410 km^2), east Indonesia, extending approximately 60 km from north to south and approximately 340 km from west to east. The island is located at the north of Ambon, the provincial capital.

Central Seram comprises Amahai, Masohi, Seram Utara and Tehoru districts. It has a population of 14.13 people km^{-2} in 2008 (BPS Kabupaten Maluku Tengah 2009). The present study was conducted in an upland community in the forested interior of central Seram (Figure 1).

In central Seram, there is a certain amount of forest degradation and deforestation in the lowlands in the northern coastal areas. This is caused by cacao plantations, shrimp farms and transmigration programmes as well as commercial logging of meranti (*Shorea* spp.) and merbau

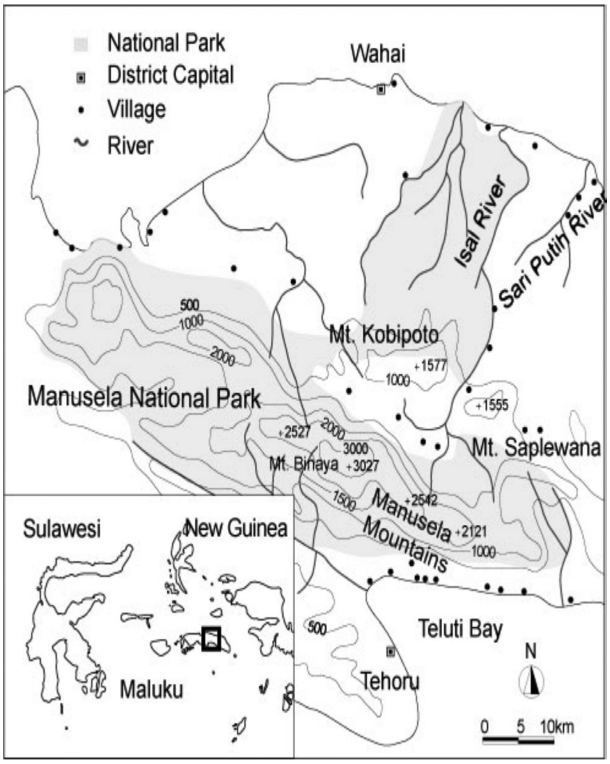

Figure 1 Research site on Seram island, eastern Indonesia

(*Intsia bijuga*) (Badcock 1996). In addition, a large forest area in the northern coastal lowlands was cleared for oil palm plantation in 2009. Nevertheless, large tracts of mature natural forest remain in other rural areas in central Seram, especially in the interior mountainous area (Figure 2).

The study village, Manusela, is in the most remote area of the island. In 2010, the population of Manusela was approximately 320 (59 households). As there is no navigable road; the only means of getting to the coastal area where local markets are situated is by foot. The journey to the north coast takes two or three days, while the journey to the south coast takes one day.

Manusela lies about 810 m above sea level. Sago palm is believed to occur naturally up to an altitude of about 700 m above sea level (Rasyad & Wasito 1986). The Manusela area is, therefore, not ideal for sago cultivation. Nevertheless, the local people are highly dependent on sago as a staple food.

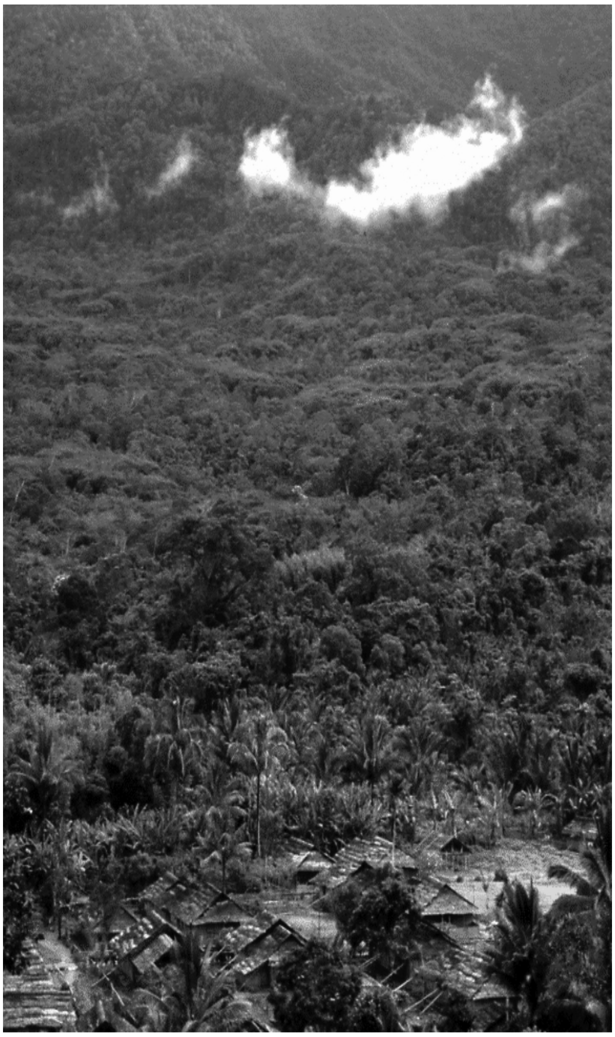

Figure 2 Rich natural forest-dominated landscape around the study community

The main economic activities in the village include sago extraction (Sasaoka 2006), banana and tuber crop cultivation, hunting and trapping, as well as gathering non-timber forest products such as wild edible plants, rattan and wild honey. These activities are primarily conducted for subsistence purposes. The villagers also engage in seasonal migrant work such as harvesting cloves in the southern coastal area during the harvest season (September–November). They also occasionally sell non-timber forest products such as wild parrots and wild honey in coastal areas (Sasaoka 2008).

The high dependence on sago as a starchy staple food and the inaccessibility of coastal fishing waters and local coastal markets for purchasing fish and meat mean that game animals are indispensable for local diets. Most hunting and trapping grounds are located within Manusela National Park (189,000 ha), which was established in 1989. Nearly half of the village territory of Manusela is situated inside the park, with the nearest boundary of the park about 2 km from the settlement. Although current Indonesian law prohibits hunting and trapping inside national parks, weak enforcement enables the local people to continue catching game animals.

Data collection

Interviews were conducted in Indonesian without an interpreter.

General information on sago-based vegeculture

Key informant interviews, group interviews and participatory observation took place intermittently between 2003 and 2010. The interviews aimed to gather data on local knowledge and techniques for sago-based vegeculture including land preparation and management, folk categorisation of sago growth stages and seasonality of agricultural practices. One-to-one interviews were conducted with members of 15 households to obtain data on cultivation and fallow periods in shifting cultivation and main crops grown in shifting cultivation fields.

Sago starch content and density of mature sago palm stands

Wet sago starch extracted from 41 sago palms in 2003 was weighed using a spring scale. Mapping using measuring ropes for 15 sago groves (spanning a total area of 1.9 ha) that were randomly selected was carried out. Boundaries of sago grove were plotted on graph paper by extending measuring ropes to the sago grove edge and calculating the area of each sago grove. The number of mature sago palm stands in each sago grove was counted in order to calculate the harvestable sago stand density.

Dependence on sago and staple food preferences of local people

To determine the extent of local people's dependence on sago, data on staple food intake were collected from 5 June till 30 August 2003. Houses were selected at random and staple foods of villagers were weighed before and after meals. The survey was conducted 19 times (92 individuals) for morning meals, 17 times (92 individuals) for mid-day meals and 21 times (115 individuals) for evening meals. Energy consumption was calculated based on the following calorie amounts: sago 2210 kcal kg^{-1}, sweet potato 770 kcal kg^{-1}, banana 1150 kcal kg^{-1}, taro 1300 kcal kg^{-1} and cassava 1490 kcal kg^{-1} (Ohtsuka & Suzuki 1990). Data on the frequency of consumption of staple food items were collected using self-administered questionnaires during four periods: May–June 2003 (21 days, 19 households); July–August 2003 (21 days, 16 households); November–December 2003 (22 days, 17 households) and February–March 2004 (18 days, 15 households). Frequency of consumption was calculated by dividing the number of times that a food item was consumed by the total number of meals during the time period. To determine preferences for staple foods (those that met energy needs and were eaten frequently), a scoring exercise was conducted in 2004. Based on key informant interviews, three aspects of staple foods were considered most important by villagers: good for satiety and energy, quenched thirst and wouldn't get bored even if eaten everyday. Twenty-three villagers (men and women) were selected at random to score each staple food item (sago, sweet potato, banana, taro and cassava) against these three criteria on a five-point scale.

Size of cultivation fields

The shifting cultivation fields of 13 households selected at random were measured in 2004 using measuring ropes. In total, 69 shifting cultivation fields were measured.

RESULTS

Sago-based vegeculture

Sago palm cultivation

Villagers created almost all the sago groves in Manusela territory by clearing swampy grounds and the area alongside streams and transplanting sago palm suckers. The sago groves consisted of sago palms at various stages of growth (Figure 3). When a mature sago palm is felled for starch extraction, new suckers grow from the stump or root. This means that, in contrast to the main crops grown in shifting cultivation such as upland rice, sago can be continually harvested at the same place.

According to villagers, sago palms in Manusela could be harvested at the age of about 15 years. Villagers claimed that their sago palms were highly resistant to pests, diseases and wild animals.

Shifting cultivation

Inhabitants of upland communities in central Seram practised two types of shifting cultivations: intensive root crop and vegetable garden or *lela* in the local language, and extensive banana and taro garden or *lawa* (Figure 3, Table 1).

Lela is relatively intensively managed. A garden can be established at any time, regardless of the season. After the secondary vegetation is cleared, litter such as branches and leaves is removed; weeding is frequent. The main crops of *lela* include root crops such as taro, cassava and sweet potato, various vegetables (*Brassica juncea, Brassica oleracea, Amaranthus* spp.), tobacco (*Nicotiana tabacum*) and cayenne (*Capsicum annuum*). In establishing *lela*, villagers may burn fields in the dry season but not in the rainy season (November–April). *Lela* is gradually abandoned

Figure 3 Sago groves and shifting cultivation fields in the study area: (a) sago grove; (b) intensive root crop–vegetable garden and (c) extensive banana–taro garden

Table 1 Characteristics of shifting cultivation gardens in an upland community in central Seram

Type	Land preparation and management	Main crop	Burning	Cultivation period (years)	Fallow period (years)
Intensive root crop–vegetable garden *(lela)*	- Secondary vegetation cleared - Litter (branches and leaves) removed - Frequent weeding	Root crop (taro, cassava, sweet potato), vegetable, tobacco, sugar cane	Occasional (dry season)	1–2	± 10
Extensive banana–taro garden *(lawa)*	- Secondary vegetation cleared - Litter not removed - Infrequent weeding	Banana, taro, fruit tree (langsat, jackfruit)	No	3–10	15–40

1–2 years after establishment, with an average fallow period of about 10 years.

Lawa, by contrast, is relatively less intensively managed. After the secondary vegetation is cleared, litter is not removed. Weeding is infrequent and fire is not used. The main crops grown in *lawa* are taro and several varieties of banana (12 varieties with various ripening periods). Villagers sometimes plant fruit trees such as langsat (*Lansium domesticum*) or jackfruit (*Artocarpus heterophyllus*) along edges of fields.

After the taro is harvested, *lawa* functions as a banana garden. Mature banana stands with ripe bananas are felled after fruits are harvested. However, because young banana shoots sprout from the corm, banana can be cultivated and harvested in the same place over a long period if the garden is well maintained through clearing of underbrush and vines. Most *lawa* is abandoned 3–10 years after establishment because of pest damage and weeds. Nevertheless, one *lawa* had been cultivated continuously for about 25 years. Although many informants could not specify the fallow period for *lawa*, it appeared to be 15–40 years.

Land productivity of sago groves

Villagers identified seven growth stages of sago palm (Table 2). The density of sago palm stems during the *upepoto* and *rapulili* stages was 76.3 stems per ha (A). According to key informant interviews, sago palm takes 4–6 years to grow from the early *upepoto* stage to *ropu ropu* (B). Therefore, assuming that sago groves have the same age composition, the number of harvestable sago stems per ha per year was 12.7–19.1 (estimated by dividing A by B). Results of measurements of the amount of sago starch indicated an average of 68 kg per stem^{-1} (dry weight).

Based on these figures, we estimated the amount of sago starch produced at 864–1299 kg ha^{-1} year^{-1} (dry weight). Assuming a ratio of wet weight to dry weight of 1:0.55 and an energy content of wet sago of 2210 kcal kg^{-1} (Ohtsuka & Suzuki 1990), we calculated the energy value at 347–522 $\times 10^4$ kcal ha^{-1} year^{-1} (Table 3). These results indicated that the productivity of sago groves was 5–16 times higher than the actual land productivity of upland rice fields (land productivity calculated by taking into account fallow land and the period) throughout South-East Asia, which had been calculated at 32–64 $\times 10^4$ kcal ha^{-1} year^{-1}, assuming an annual upland rice yield of 1–2 tons ha^{-1} (Hansen 1995, Wadley 1997, Mertz 2002). This is the energy amount from a 2-year cultivation period and a 20-year fallow period. This relatively high land productivity of sago groves appears to be attributable to the fact that sago can be harvested continually at the same place.

Local dependence on sago

As shown in Figure 4, sago is clearly the most important staple food for villagers in Manusela, accounting for 76% of the total staple food intake in terms of energy. Sago was also the most frequently consumed staple food (Figure 5).

Results of the scoring exercise with regard to local staple food preference show why the study community depends so heavily on sago and values it so highly. Sago scored highest (Figure 6) in all criteria (good for satiety/energy, quenching thirst and not becoming bored even if eaten everyday).

Size of shifting cultivation fields

Surveys to measure sizes of cultivation fields conducted for all shifting cultivation gardens

Table 2 Sago palm growth stages according to local community

Growth stage	Description
Anania	Sucker
Waieri	Palm beginning to form trunk
Sapei tupe	Palm with woody trunk but still short
Upepoto	Palm with relatively tall trunk; has not sprouted small leaves around the crown
Rapulili	Palm with relatively tall trunk; small leaves around the crown
Ropu ropu	Mature palm with a peduncle; suitable for harvesting
Atamoto	Palm with peduncle already fallen

The *ropu ropu* growth stage has three subcategories

Table 3 Estimated productivity of sago groves and basic data used

Number of harvestable sago	12.7–19.1 stems ha^{-1} year^{-1}
Amount of sago starch (dry weight)	68 kg stem^{-1}
Amount of harvestable sago starch (dry weight)	864–1299 kg ha^{-1} year^{-1}
Land productivity of sago groves	347–522 $\times 10^4$ kcal ha^{-1} year^{-1}

Land productivity was calculated based on the following assumptions: ratio of wet to dry weight of sago = 1:0.55 and energy content of wet sago = 2210 kcal (Ohtsuka & Suzuki 1990)

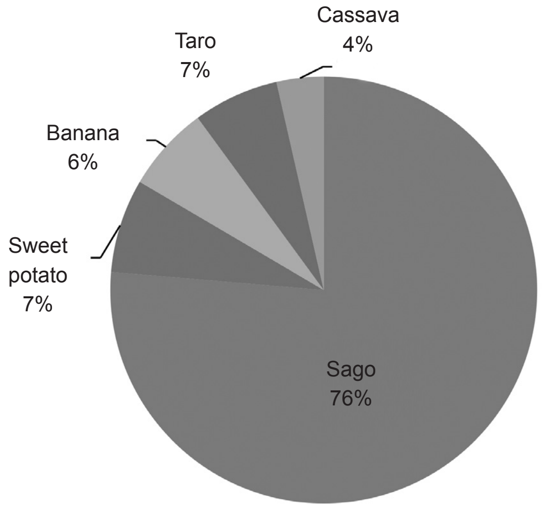

Figure 4 Proportion of energy intake staple foods

belonging to 13 households (21 *lela* and 48 *lawa*) indicated an average of 0.22 ha/household (Table 4). This is much smaller than shifting cultivation fields elsewhere, i.e. only 12–16% the average size of shifting cultivation fields for upland rice or millet in South and South-East Asia (1.4–1.8 ha household^{-1}) (Sasaki 1998).

DISCUSSION

Sago groves, which produce highly valued staple food for local communities, attract less of other landuses because they require relatively small amounts of land to meet local energy needs and exhibit higher land productivity than shifting cultivation for upland rice. Our investigations of

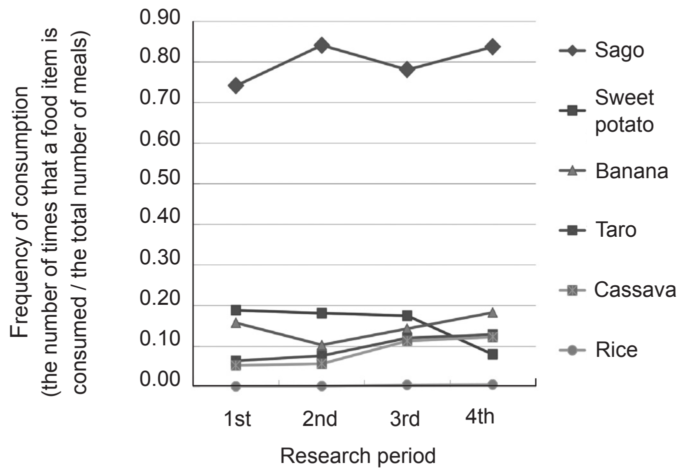

Figure 5 Frequency of intake of staple foods; 1st = May–June 2003 (21 days), 2nd = July–August 2003 (21 days), 3rd = November–December 2003 (21 days), 4th = February–March 2004 (18 days)

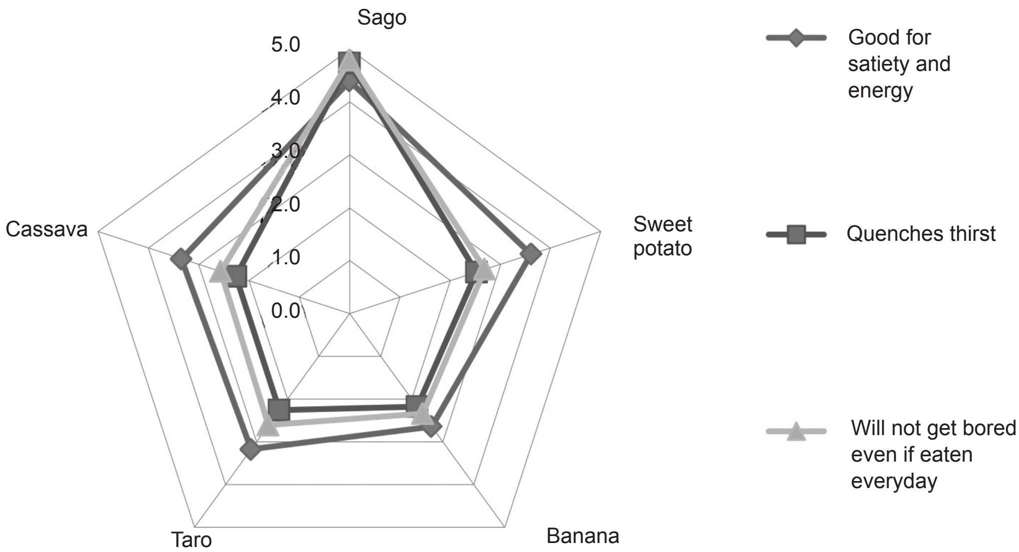

Figure 6 Preference for various staple food items (0 = lowest score, 5 = highest score)

Table 4 The size of shifting cultivation gardens per household

Type of garden	Average number of garden cultivated (fields/household)	Average size of garden (ha/household)	Total number of garden measured
Lela	1.6	0.04	21
Lawa	3.7	0.18	48
Total		0.22	69

shifting cultivation fields revealed that farmers in Manusela practised shifting cultivation on a very small scale for two main reasons. First, the community's heavy dependence on sago means the people do not need large shifting cultivation gardens to produce supplementary staple food crops. Second, the vegetatively-propagated crops that constitute the main crops in shifting cultivation can be harvested all year round and banana can be cultivated continuously at the same place over long periods of time.

The small scale of shifting cultivation in Seram meant that local agriculture exerted relatively little pressure for forest clearance. In addition, the low population density and subsistence-oriented agriculture meant that the practice of sago-based vegeculture could support the maintenance of rich natural forest characteristics of the Seram landscape. Thus, this form of agriculture appears to help sustain the relatively high levels of local biodiversity and carbon stocks.

Not only does sago continue to be an important staple food in some areas of east Indonesia and New Guinea, sago palm is regarded as one of the most important bioresources for sustainable agriculture and rural development in swampy tropical areas (Ehara et al. 2000). Sago palm is a subject of both concern and interest in the context of food security because of its high productivity and tolerance to high salt and acid in the soil (Ehara 2009). However, the compatibility of sago-based agriculture with natural forest has not been sufficiently assessed.

By analysing the land productivity of sago groves, local dependence on sago as a staple food and the size of shifting cultivation fields, we identified a possible role of sago-based vegeculture in supporting the maintenance and formation of landscapes dominated by rich natural forest. Further studies are needed to elucidate the link between sago-based vegeculture and forest-dominated rural landscapes and to assess the value of sago-based vegeculture in terms of biodiversity conservation and carbon sequestration.

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