Utilising non-timber forest products to conserve Indonesia's peat swamp forests and reduce carbon emissions

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Abstak

Degradasi dan konversi hutan rawa gambut Sumatera dan Kalimantan telah menyebabkan meningkatnya emisi CO_2 dan menempatkan Indonesia sebagai emitor utama dalam peningkatan emisi gas rumah kaca. Pengeringan lahan gambut tidak hanya meningkatkan proses oksidasi dan resiko kebakaran, tetapi juga mengakibatkan terjadinya penurunan permukaan tanah dan mengakibatkan genangan. 7 juta ha lahan gambut di Sumatera dan Kalimantan telah memiliki izin untuk dikembangkan sebagai areal perkebunan seperti kelapa sawit serta Akasia yang membutuhkan pembangunan drainase serta berkontribusi untuk emisi CO_2 dan penurunan permukaan. Menanam spesies hutan rawa gambut yang bernilai guna namun tidak membutuhkan sistim drainase dalam program budidaya tanaman di areal gambut "Paludiculture", bisa menjadi suatu hal menarik secara ekonomi dan alternatif yang berkelanjutan. 1376 jenis tanaman telah tercatat di kawasan hutan gambut dataran rendah di Asia Tenggara. 534 (38.8%) jenis tanaman telah diketahui pemanfaatannya, diantaranya untuk kayu (222 jenis), obat-obatan (121), makanan (165 jenis, seperti buah-buahan, biji dan minyak). Banyak diantaranya memiliki kegunaan ganda dan 81 jenis dari hasil hutan bukan kayu ini dilaporkan sebagai "sumber perekonomian utama". Kajian nilai ekonomis awal bahwa berdasarkan laba yang diperoleh, beberapa spesies asli tanamam hutan gambut yang alami berpotensi dapat bersaing dengan kelapa sawit dan Akasia. Jelutung rawa (*Dyera polyphylla*) adalah alternatif yang menarik bagi masyarakat setempat yang menawarkan keuntungan yang lebih dari sisi tenaga kerja dibandingkan kelapa sawit.

Abstract

Degradation and conversion of peat swamp forests of Sumatra and Kalimantan has led to enhanced CO_2 emissions and contributed to Indonesia being a major emitter of greenhouse gases. Drainage of peatland not only increases oxidation and fire risk, but leads to soil subsidence and undrainable conditions. 7 Mha of peatland on Sumatra and Kalimantan are licensed for plantation crops such as oil palm and Acacia that require drainage and contribute to CO_2 emissions and subsidence. Planting useful peat swamp forest species that do not require drainage in a 'paludiculture' (swamp cultivation) programme could provide an economically attractive and sustainable alternative.1376 plant species have been recorded in lowland Southeast Asian peat swamp forests. 534 (38.8%) species have a known use, for timber (222 species), medicine (221), food (165, e.g. fruits, nuts, oils) and other uses (165, e.g. latex, fuel, dyes). Many have multiple uses and 81 non-timber forest product species have a reported 'major economic use'. An initial economic assessment indicates that based on returns, some indigenous peat swamp forest species are potentially competitive with oil palm and Acacia. Swamp jelutung (*Dyera polyphylla*) is an attractive alternative for local communities as the return on labour is greater than for oil palm.

Keywords: *peatland rehabilitation, Indonesia, useful plants, peat swamps, paludiculture*

Introduction

Peatland areas extend over 13 Mha in coastal lowlands of the islands of Sumatra and Borneo (Silvius et al. 1987, Miettinen and Liew 2010) where they commonly occur in domes of up to 6-15m depth. These peatlands were originally forested, and most (84%) of Indonesia's peat swamp forest (PSF) is classified as forestry land, of which 28% is protected forest (mainly in Papua), 47% production forest and 25% conversion forest (Mawdsley et al. 2013). Logging of PSFs peaked in the early 1990s and by 2010, 69-72% of Sumatra's PSF had disappeared, with only 4.6% remaining as 'pristine forest'; on Kalimantan (Indonesian Borneo) the situation is similar, with 50-53% of the PSF having

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disappeared and only 2.1% remaining in a pristine condition (Miettinen and Liew, 2010; Posa et al., 2011). Since 2000, there has been a major expansion of plantations into peatland, especially for oil palm (*Elaeis guineensis*), northern or red wattle (*Acacia crassicarpa*) for pulp, and to a lesser extent for (smallholder) rubber (*Hevea brasiliensis* (Miettinen et al. 2012). Plantation licenses have been issued for over 7 million hectares of peatland (Mawdsley et al. 2013), of which about half is considered deep peat (>2m), while a further 2.5 million hectares of mostly shallow peatland have been cultivated by smallholders (Miettenen and Liew 2010; Mawdsley et al. 2013). By mid-2012, only parts of these licensed areas have been developed, extending over about 2.0-2.5 million hectares (Mawdsley et al. 2013). Peat with a depth of 3m or more is officially protected by Presidential Regulation 32 of 1990 (Silvius and Giesen 1996), but this legal status has not reduced peat degradation or development.

Peatland use commonly involves drainage of peat, either to facilitate the extraction of logs, or because rubber, Acacia and oil palm require water tables to be lowered 50-60 cm below the peat surface to facilitate growth and productivity (Sheil et al. 2009). Drainage leads to peat compaction, subsidence, irreversible desiccation and oxidation and in unmanaged conditions often accompanied by fires. According to the Indonesian Council on Climate Change (press release 10th September 2009) "[CO_2] Emission from peatland amounts to 45% and forestry 35% of Indonesia's greenhouse gas emission." This has made Indonesia the 3rd largest CO_2 emitter world-wide (Hooijer et al. 2006, Hooijer et al. 2010). Perhaps the greatest threat posed by drainage-based development of peatland is that 70% of peatland in Indonesia has a mineral sub-soil that lies close to mean sea level and cannot be drained by gravity alone. It is estimated that, after 25 years, 46% of peatland will be below the drainage base-level, and after 100 years this may increase to 85% (Hooijer et al. 2012). While careful water management in plantations may reduce current emissions (Kalsim, 2009), gains remain small (20% reduction; Hooijer et al 2012). The need for lower water tables for oil palm, Acacia and rubber plantations means that these will always be net emitters of carbon, and initial gains are often entirely lost upon harvest (Hooijer et al. 2012).

The Government of Indonesia (GOI) has recognized these issues and seeks alternatives, with agencies and government programmes assessing sustainable alternatives. At the same time, initiatives by NGOs in degraded peat landscapes include testing PSF species for replanting and peatland rehabilitation programmes. However, the number of species used to date in peatland trials (by GOI agencies) and rehabilitation (by NGOs) has been very limited (<40) and often does not include useful species or reflect the true potential of PSFs (Giesen, 2013).

Paludiculture is a swamp cultivation approach developed in northern temperate areas as a means of rehabilitating degraded peatland, while making these economically useful at the same time (Wichtmann and Joosten, 2007, Schäfer 2011). In many cases, this involves the planting of, for example, common reed (*Phragmites communis*) and alder (*Alnus glutinosa*) on degraded albeit rehydrated peatland to prevent further peat degradation and loss. An assessment by Barthelmes et al. (2014) suggests a whopping 450,000km² with a potential for paludiculture Worldwide, with about 90,000km² in Indonesia alone.

This paper assesses opportunities for paludiculture on degraded Indonesian peatland. The paper aims at identifying PSF species with a non-timber forest product potential that can possibly compete financially with oil palm, rubber and Acacia that are currently the preferred crop planted on peatland.

Methods

In this study, a PSF plant species data base was cross-referenced with existing literature on plant use in the region. This was followed by a review of existing and past attempts to cultivate PSF species on degraded peatland and assessing its economic potential. Over the past five years, a PSF plant species database[1] was compiled from species habitat records in key taxonomic references (Flora Malesiana [FM], Tree Flora of Malaya, Flora of Java), scientific papers and grey literature/ reports on peat swamp forests. Species records with ambiguous taxonomy or locality were excluded. Taxonomy follows Flora Malesiana, or when outdated (FM began in the 1950s) the contemporary The Plant List (2010) Version 1 (http://www.theplantlist.org/). It was assessed if a species was restricted to the lowland peat swamp habitat, by referring to habitat listed in the key taxonomic references mentioned above, and cross-checked with herbarium records accessible via the Global Biodiversity Information Facility Version 1.2.6 (http://data.gbif.org/), in which all major herbaria with Southeast Asia collections collaborate. Some leniency

[1]The database was developed in Microsoft Excel

was afforded in cases when some records list ‘swamp’ as habitat type, although strictly speaking, this could refer to freshwater swamps on mineral soils. In such cases, the information was used to remove a species from the list.

PSF plant uses was based on existing literature, especially Heyne (1950) and the Plant Resources of South-East Asia Programme (PROSEA) that was active from 1990-2004 and involved FRIM (Malaysia), LIPI (Indonesia), IEBR-NCSR (Vietnam), UNITECH (Papua New Guinea), PCARRD (The Philippines), TISTR (Thailand) and Wageningen Agricultural University (the Netherlands). The PROSEA programme developed 19 volumes on plant uses, listing 7000+ species and arranged by commodity groups. Peatland cultivation programmes by the Ministry of Forestry, Forestry Research Institute (FORDA, Bogor, West Java), Swamp Agricultural Research Agency (BALLITRA, Banjarbaru, South Kalimantan), University Gadjah Mada (Yogyakarta, Central Java), University Tanjungpura (Pontianak, West Kalimantan) and the World Agroforestry Centre (ICRAF, SEA Regional Office, Bogor) were assessed.

An assessment was also made of the number of PSF species with a major (past or present) economic use. This was based on criteria used by the PROSEA programme that lists species according to major or minor use, and by existing research programmes that focus on species with promising economic potential (e.g. ICRAF programmes).

Results

The peat swamp database is based on 135 references and includes 1467 plant species. Of these, 1376 are lowland swamp species, including 1326 angiosperms and 720 trees and shrubs. Of 1376 lowland peat swamp forest species belonging to 136 plant families, the main ones are Rubiaceae (79 species), Myrtaceae (61), Dipterocarpaceae (55), Myristicaceae (54), Lauraceae (49), Arecaceae (40), Euphorbiaceae and Anacardiaceae (each 38). Of these 1376 species, 110 (8.3%) were found to be restricted to the lowland peat swamp habitat.

Cross-referencing with plant use references reveals a list of 534 useful PSF species, of which 514 occur in Indonesia. The main uses are timber (222 species), medicine (221), and food (165), while a category of ‘other uses’ includes 192 species. Many species have multiple uses. Figure 1 indicates species per use (or commodity) sub-category for food, medicinal and ‘other use’ species. Fuel wood was not included in the assessment, because it is too ubiquitous with limited economic value. A total of 81 species yielding non-timber forest products were recognized as having a major economic use, either by PROSEA (64 species) or by the present study (17 species). These are listed in Table 1 and include 22 fruit and nut species, 11 weaving and fibre species, 7 edible oil/fat, 7 latex, 6 incense, 6 starch, 6 resin, 4 tannin and dye, 4 vegetable, 3 rattan, 3 tea and spice, and 2 fuel oil producing species.

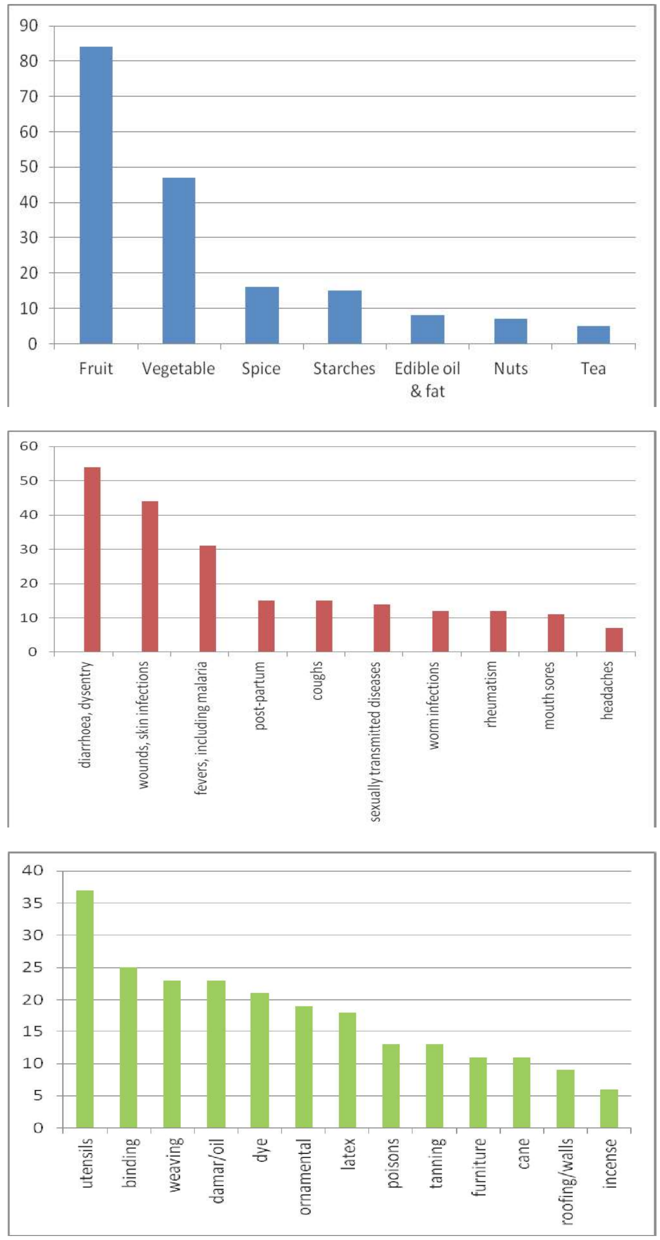

Figure 1. Non-timber Forest Product species in Indonesian peat swamp forests

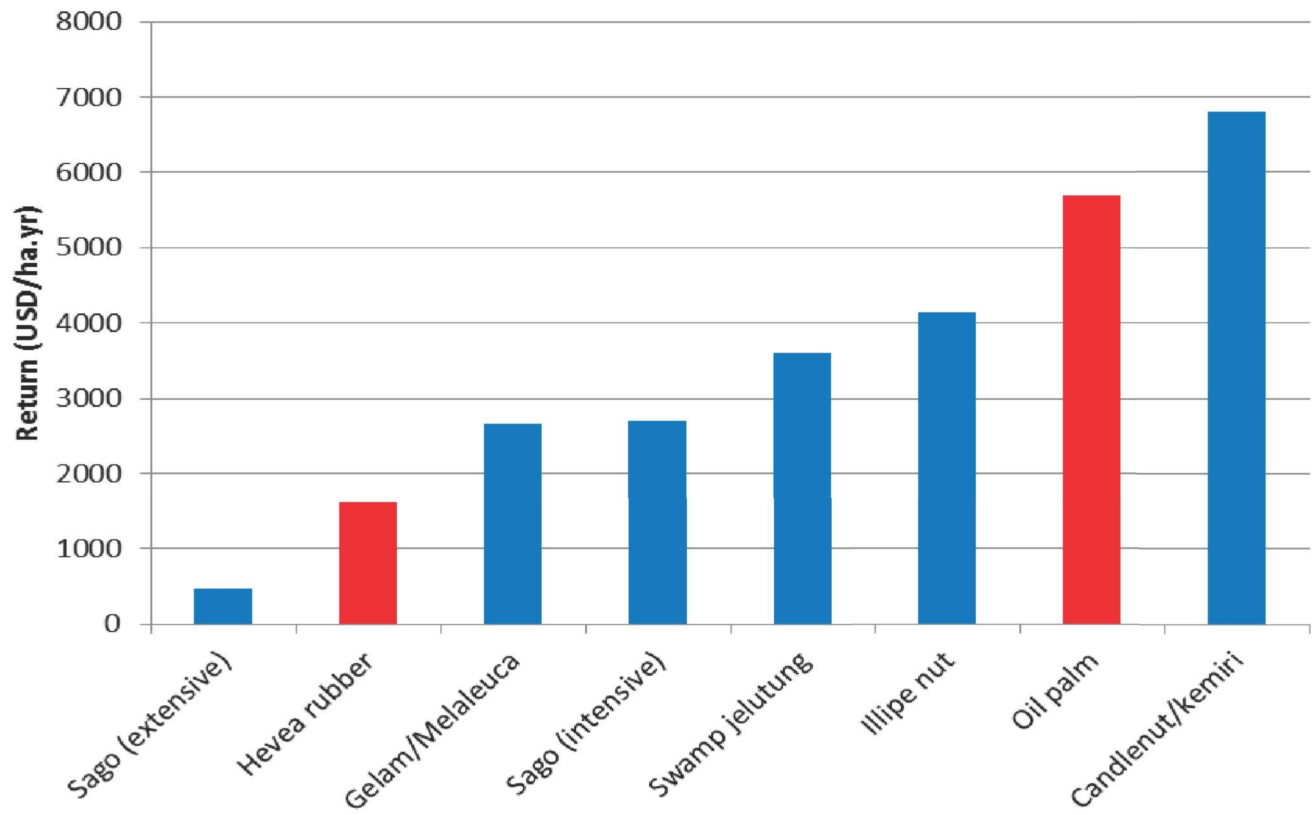

Figure 2. Financial returns of agricultural commodities grown on peat. **Sago**: Flach and Schuiling 1989, Sonderegger and Lanting 2011; **Hevea rubber**: Sonderegger and Lanting 2011; **Gelam/Melaleuca**: Duc and Hufschmidt 1993; **Swamp jelutung**: Sofiyuddin et al. (2012); **Illipe nut**: Smythies 1961, Blicher-Mathiesen 1994; **Oil palm**: Sheil et al. 2009, Sofiyuddin et al.2012b; **Candlenut/Kemiri**: Manap et al.2009, Kibazohi and Sangwan 2011.

Discussion

Few records exist of the total number of PSF plant species, with most enumerations specific to one locality, and taxonomic uncertainties and frequent revisions make comparisons difficult. However, the total number of lowland peat swamp forest plant species identified in this study (1376) is comparable to that of Posa et al. (2011), who listed 1524 species for Southeast Asia PSFs, and Anderson (1963) who recorded 1706 herbarium numbers[1] collected in PSFs of Sarawak and Brunei. The percentage of useful species (534 out of 1376) is 38.8% of the lowland PSF flora. This compares to 81 % for non-fuel wood use of the mixed freshwater and peat swamp forests at Danau Sentarum National Park in West Kalimantan, Indonesian Borneo (Giesen and Aglionby, 2000). Similar information from other Southeast Asian swamp forests is lacking, but from *terra firma* in Amazonia, Prance et al. (1987) recorded that indigenous people used 48.6-78.7 % of the tree species >10 cm dbh on a 1-ha plot inventoried. Peters (1994) reports that one in six species found in Southeast Asian forests, including dry land forests, produces edible fruit, nut, oil seed, medicine, latex, gum or other non-timber forest resource.

[1]This included duplicates and 5% sterile specimens

Promising species for rehabilitation programmes

The 81 species with major economic benefits are listed in Table 1 and considered to be promising for use in existing and planned peat swamp rehabilitation programmes (e.g. Ex-Mega Rice Project Area in Central Kalimantan; buffer zone of Berbak National Park in Jambi, Sumatra; Tripa peat swamp in Aceh, Sumatra). Many of these species, however, are not typically recognised as common to PSFs. Some, such as candlenut (*Aleurites moluccana*), rambutan (*Nephelium lappaceum*), mangosteen (*Garcinia mangostana*) and longan (*Dimocarpus longan*) are commonly grown in community gardens and backyards, and few are aware that these species are found in peat swamps. However, as evident from the assessment of PSF species, only a relatively small percentage of angiosperms found in PSFs are restricted to peatland. Posa et al. (2011) recorded 172 (11%) species restricted to PSF, while in the present study, 110 (8.3%) species restricted to lowland PSFs were recorded. Many species are shared with other habitats, including non-flooded lowlands, heath forest (*kerangas*), montane forests and village gardens.

The aim of this study was to identify useful plant species suitable for rehabilitating degraded peatland. Therefore, the emphasis was on identifying species yielding Non-timber Forest Products (NTFPs). The list of 81 "potentially useful species" does not include timber or pulp species, because timber and pulp production require actions (e.g. clear felling) detrimental to peat conservation (Hooijer et al. 2012). Nevertheless, PSFs include many high value timber species (e.g. ramin, *Gonystylus bancanus* and a range of dipterocarp species) and species with the potential for pulp production. Medicinal plants are not included in the 81 "potentially useful species", because the medicinal plants market is notoriously difficult to develop and specific beneficial compounds are often synthesized after their discovery. The potential for bio-prospecting PSFs for medicinal plants may be significant, though, because peat swamp plants produce chemical compounds (e.g. alkaloids) to deter herbivory at a much higher level than species in non-flooded areas. This is especially evident, when the same species occurs both on mineral and peat soils: on peat they are more toxic (pers. comm. C. Yule, March 2013), and novel properties have been identified. For example, *Calophyllum teysmannii* (var. inophylloide was found to have anti-HIV properties and a promising new line of coumarins used in chemotherapy was developed for medical purposes (Fuller et al.1994).

There exists alternatives for Acacia, oil palm and Hevea rubber, the three main commodities cultivated on Indonesian peatland. A recent study by Suhartati et al. (2012) identified six indigenous pulp species that may provide promising alternatives to *Acacia crassicarpa* on peat, namely *Campnosperma coriaceum*, *Cratoxylum arborescens*, *Endospermum diadenum*, *Macaranga gigantea* and *Macaranga hypoleuca,* and *Neolamarckia cadamba*. Candlenut or kemiri *Aleurites moluccana* is a promising oil producing alternative on degraded peat and may produce more oil and economic revenue per hectare of land than oil palm. Trials by University Gadjah Mada (Yogyakarta) were carried out on hydrated 1-3m deep peat in West Kalimantan from 2003-2009 with various illipe nut (tengkawang) species that produce a high value edible fat. The trials focused primarily on *Shorea pinanga*, *S. macrophylla* and *S. stenoptera*, as well as *Shorea guiso*, *S. teysmanniana*, *S. compressa*, and *Vatica mangachapoi*. Of these, *S. guiso*, *S. teysmanniana* and *V. mangachapoi* occur naturally in PSFs, but all seven species performed well on peat, with girth increments similar to that on mineral soils (pers. comm. O. Karyanto, UGM, 2013). It is likely that the other four tengkawang species also occur in peatland, but they have not yet been recorded, most likely due to their irregular flowering and fruiting patterns. At its origin, *Hevea brasiliensis* is considered a swamp species and can be productively cultivated on hydrated peat, although shallowly drained peat (e.g. 20-40 cm at Padang Island, Riau, Sumatra) may increase productivity (Sonderegger and Lanting 2011; Giesen 2013).

Economics of peat swamp NTFPs

The question remains if NTFPs can compete with the main plantation crops economically on peatland. There have been few economic studies on NTFPs in peat swamps: on sago (*Metroxylon sagu*) and Hevea rubber (Sonderegger and Lanting, 2011) and swamp jelutung (*Dyera polyphylla*) (Sofiyuddin et al. 2012). Production figures are known for other commodities on mineral soil, such as tengkawang (illipe nuts), paperbark (gelam or *Melaleuca cajuputi*) and candlenut (*Aleurites moluccana*), and these can be interpolated for peat soils. Productivity on hydrated peat is often lower than on mineral soils, and sago, for example, is found to be 25% less productive on hydrated peat (Flach and Schuiling, 1989). Not all commodities are less productive on peat than on mineral soil. Asia Pulp and Paper manages *Acacia crassicarpa* plantations with an average production of 25 tons/ha/yr (max. 35 tons/ha/yr), with the best results being on deep peat (pers. comm. C. Munoz, APP, 2013).

Figure 2 displays returns (USD/ha/yr) for plant products on peat, including rubber, palm oil, sago, swamp jelutung, gelam, illipe nut and candle-nut. These figures are from peatland studies (Duc and Hufschmidt 1993, Sonderegger and Lanting 2011, Sofiyuddin et al. 2012), or from studies on mineral soils, with production figures adjusted downward (-25%) to reflect a possible lower productivity on peat. Values have been corrected for inflation to reflect 2014 prices. In addition, illipe nut displays mast fruiting every 3-4 years, so the average non-mast return (460-3000 USD/ha/yr) was combined with the average mast fruiting return (8800-11500 USD/ha/yr) on a 3.5:1 basis (Smythies 1961, Blicher-Mathiesen 1994). Therefore, returns vary from USD 480/ha/yr for extensive, low input sago on Padang Island (Sonderegger and Lanting, 2011) to USD 6800/ha/yr for candle-nut (combined data from Manap et al. 2009 and Kibazohi and Sangwan 2011). Several commodities (e.g. candlenut, illipe nut and swamp jelutung) appear in the same level as oil palm.

Other economic aspects need to be taken into account too. In a comparative economic study of swamp jelutung and oil palm on degraded peat (Sofiyuddin et al. 2012), swamp jelutung returns were 37% lower than oil palm, but labour return was higher i.e. US$ 16.46 per person day for swamp jelutung against US$ 16.06 for oil palm. For smallholders with adequate access to land, return on labour is often more important than return per hectare per year, while for plantation companies the return per hectare is more significant, because licensing is usually area based. Research and selection trials on swamp jelutung could further boost production, as commodities such as palm oil Acacia and Hevea rubber have benefited from many decades of research, selective breeding and cloning. Initial trials with indigenous swamp forest species have been undertaken, but yield optimisation with regards to swamp jelutong remains in its infancy and there is a great scope for further knowledge expansion. A study by Turjaman et al. (2006) in Central Kalimantan, for example, found that inoculation of growth medium with arbuscular mycorrhizal fungi boosts the growth rate of swamp jelutung.

Swamp jelutung, illipe nut and oil palm trees become less productive and need to be replaced over time; oil palm after 25-30 years (Basiron and Weng 2004), swamp jelutung after 30-40 years, while illipe produces nuts much longer, although it is not yet known how many years it will still be commercially productive. Replacement of any crop is an additional cost. For oil palm it means that the palms are uprooted and removed from the site. For swamp jelutung, however, the timber is much sought after for fine carpentry, carving and pencils and felling leads to added benefits. It can fetch up to US$ 700-800/m^3. Likewise, most of the Shorea species producing illipe nuts also produce a valuable timber (PROSEA, 1990-2004).

Additional benefits can be secured by using peat adapted species in programmes that include rehabilitating the hydrology of degraded peatland, thereby curbing and preventing peat loss. These benefits may be monetized, for example, on payment for carbon credits under an REDD+ scheme. Areas rehabilitated under a paludiculture programme provide health benefits and leads to fewer transport disruptions by reducing the number of fires and, consequently, lowering the volumes of smoke. Costs for regular deepening and upgrading of drainage are avoided under a paludiculture regime. This knowledge is also embraced by the palm oil industry, where the Roundtable on Sustainable Palm Oil (RSPO) recently prohibited RSPO members from peat development (Schrier-Uijl et al. 2013). In addition, the Indonesian President issued a decree to prevent further peat development, precisely because there is very clear links to increased number of wildfires and smoke problems and excessive peat development.

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Table 1. Peat swamp forest plant species with significant commercial potential. Some species exhibit potential economic returns that are at par with palm oil.

Family	Species	Common name	PROSEA No.	Main use
Anacardiaceae	Mangifera caesia Jack	binjai (I)	2	Fruit
Anacardiaceae	Mangifera foetida Lour.	limus,membacang (I), horse mango (E)	2	Fruit
Anacardiaceae	Mangifera griffithii Hook. f.	asam rawa (I)	2	Fruit
Anacardiaceae	Mangifera quadrifida Jack	asam kumbang (I)	2	Fruit
Apocynaceae	Dyera costulata (Miq.) Hook.f.	jelutung (I)	18	Latex
Apocynaceae	Dyera polyphylla (Miq.) Steenis (D. lowii)	jelutung rawa (I)	18	Latex
Araceae	Cyrtosperma merkusii (Hassk.) Schott (C. lasioides)	taro rawa (I), swamp taro (E)	9	Starch (non-seed)
Araucariaceae	Agathis borneensis Warb. (A. dammara)	damar sigi, damar pilau (I)	18	Resin
Arecaceae	Calamus caesius Blume	rotan sega (I)	6	Rattan
Arecaceae	Caryota mitis Lour.	sarai (I), fishtail palm (E)	9	Starch (non-seed)
Arecaceae	Caryota urens L.	sarai (I), fishtail palm (E)	9	Starch (non-seed)
Arecaceae	Korthalsia flagellaris Miq.	rotan dahan(-an) (I)	6	Rattan
Arecaceae	Korthalsia laciniosa (Griff.) Mart. (K. grandis)	rotan dahan(-an) (I)	6	Rattan
Arecaceae	Metroxylon sagu Rottb.	sagu (I) rumbia (Sum), sago (E)	9	Starch (non-seed)
Blechnaceae	Stenochlaena palustris (Burm. f.) Bedd.	pakis (I)	15	Vegetable
Burseraceae	Canarium asperum Benth.	kembang rekisi (I)	18	Resin
Burseraceae	Canarium hirsutum Willd.	kanari jaki, ki bonteng (I), white dhup (E)	18	Resin
Burseraceae	Canarium littorale Blume	kayu ariong (I)		Nuts
Caesalpiniaceae	Sindora velutina Baker	sepetir beludu (I)	18	Resin
Chloranthaceae	Chloranthus erectus (Buch.-Ham.) Verdcourt	keras tulang (I)	16	Tea
Clusiaceae	Garcinia mangostana L.	manggis (I), mangosteen (E)	2	Fruit
Combretaceae	Terminalia catappa Linné	ketapang (I)	3	Tannin, seed
Convolvulaceae	Ipomoea aquatica Forsk. (I. reptans)	kangkong (I)	8, 12(2)	Vegetable
Cucurbitaceae	Momordia charantia L.	bitter melon (E)	8, 12(1)	Vegetable
Cyperaceae	Actinoscirpus grossus (L.f.) Goetgh. & D.A. Simpson (Scirpus grossus)	mensiang, walingi (I), greater club rush (E)	17	Weaving
Cyperaceae	Cyperus rotundus L. (rotundatus)	teki ladang (I), red nut sedge (E)	9, 12(1)	Starch (non-seed)
Cyperaceae	Eleocharis dulcis (Burm.f.) Henschel.	purun tikus (I), water chestnut (E)	9	Starch (non-seed)
Cyperaceae	Lepironia articulata (Retz.) Domin.	purun (I), grey sedge (E)	17	Weaving
Cyperaceae	Scirpodendron ghaeri (Gartn.) Merr.	rumbai (I)	17	Weaving
Dipterocarpaceae	Dipterocarpus gracilis Blume	keruing kesat (I)	18	Resin
Dipterocarpaceae	Shorea compressaBurck	tengkawang		Oil bearing illipe nuts
Dipterocarpaceae	Shorea macrophylla (de Vriese) P.S.Ashton	tengkawang hantelok		Oil bearing illipe nuts
Dipterocarpaceae	Shorea pinanga Scheff.	tengkawang rambai		Oil bearing illipe nuts
Dipterocarpaceae	Shorea seminis (De Vriese) Sloot.	tengkawang terendak (I)	14	Oil bearing illipe nuts
Dipterocarpaceae	Shorea stenopteraBurck	tengkawang tungkal		Oil bearing illipe nuts
Dipterocarpaceae	Shorea teysmannianaDyer ex Brandis	tengkawang		Oil bearing illipe nuts
Dipterocarpaceae	Vatica mangachapoiBlanco	tengkawang		Oil bearing illipe nuts
Dipterocarpaceae	Vatica rassak (Korth.) Blume	resak (I)		Dammar/resin
Ericaceae	Gaultheria leucocarpa Blume	gandapura (I)	19	Essential oil
Ericaceae	Vaccinium bracteatum Thunb.	rangkas (I), sea bilberry (E)	2	Fruit

Euphorbiaceae	Aleurites moluccana (L.) Willd.	kemiri (I), candlenut (E)	13	Edible nut
Euphorbiaceae	Elateriospermum tapos Blume	tapas, tapus (I)		Nuts
Euphorbiaceae	Macaranga tanarius (L.) Müll.Arg.	hanuwa, mapu (I), hairy mahang (E)	3, 12(3)	Dye
Flacourtiaceae	Flacourtia rukam Zoll. & Mor.	rukam (I), India plum (E)	2	Fruit
Juncaceae	Juncus effusus Linné	sumpu (I), soft rush, common rush (E)	17	Weaving
Lauraceae	Nothaphoebe coriacea (Kosterm.) Kosterm. (Alseodaphne)	gemor (I)		Incense bark
Lauraceae	Nothaphoebe umbelliflora (Blume) Blume	gemor (I)		Incense bark
Marantaceae	Donax canniformis (G.Forst.) K.Schum.	bemban (I), common donax (E)	17	Weaving
Meliaceae	Sandoricum koetjape (Burm.f.) Merr.	sentul (I), santol (E)	2	Fruit
Menispermaceae	Fibraurea tinctoria Lour. (F. chloroleuca)	akar kuning (I), peron (Jav)	3	Dye
Moraceae	Artocarpus elasticus Reinw. Ex Blume	terap nasi, benda (I) terap (E)	17	Fibre
Myrtaceae	Melaleuca cajuputi Powell	gelam (I), paperbark (E)	19	Essential oil
Myrtaceae	Rhodomyrtus tomentosa (Aiton) Hassk.	kemunting (I)	2	Fruit
Myrtaceae	Syzygium aqueum (Burm.f.) Alston	water apple (E), jambu air (I)	2	Fruit
Myrtaceae	Syzygium polyanthum (Wight) Walp. (Eugenia polyantha)	salam, daun salam (I), Indonesian laurel	13	Spice
Nepenthaceae	Nepenthes ampullaria Jack	Katung Semar berbentuk termos (I), narrow-lid pitcher plant (E)	17	Fibre
Nepenthaceae	Nepenthes rafflesiana Jack	kantong semar Raffles (I), Raffles' pitcher plant (E)	17	Fibre
Nepholepidaceae	Nephrolepis biserrata (Sw.) Schott	pakis (I)		Vegetable
Olacaceae	Anacolosa frutescens (Blume) Blume	kopi gunung, belian landak (I)	2	Fruit
Pandanaceae	Pandanus atrocarpus Griff. (Benstonea atrocarpa)	mengkuang (I), menguang pandan (E)	17	Fibre
Pandanaceae	Pandanus furcatus Roxb.	cangkuang, pandan kowan (I)	17	Fibre
Phyllanthaceae	Aporosa frutescens Blume	sebasah (I)	3	Dye
Phyllanthaceae	Baccaurea motleyana (Müll.Arg.) Müll.Arg.	tampoi (I)	2	Fruit
Phyllanthaceae	Baccaurea racemosa (Reinw. ex Blume) Müll.Arg.	tampoi (I)	2	Fruit
Proteaceae	Finschia chloroxantha Diels	Finschia nuts (E)	2	Nuts
Rubiaceae	Uncaria gambir (Hunter) Roxb.	gambir (I),	3	Dye
Sapindaceae	Dimocarpus longan Lour.	leng-keng (I), longan (E)	2	Fruit
Sapindaceae	Nephelium cuspidatum Blume	kedet, rambutan kabung (I)	2	Fruit
Sapindaceae	Nephelium lappaceum L.	rambutan (I), (E)	2	Fruit
Sapindaceae	Nephelium maingayi Hiern	ridan, penjaih (I)	2	Fruit
Sapindaceae	Pometia pinnata Forst. & Forst.	kasai (daun besar) (I), kayu sapi (Jav)		Nuts
Sapotaceae	Madhuca motleyana (de Vriese) J.F.Macbr. (Ganua motleyana)	nyatoh ketiau (I)	18	Latex
Sapotaceae	Palaquium gutta (Hook.f.) Burck	nyatoh taban merah (I)	18	Latex
Sapotaceae	Palaquium leiocarpum Boerlage	jongkang (I)	18	Latex
Sapotaceae	Palaquium obovatum (Griffith) Engler	nyatoh putih (I)	18	Latex
Sapotaceae	Payena leerii (Teijsm. & Binn.) Kurz	balam beringin (I), balam suntei (Sum)	18	Latex
Thymelaeaceae	Aquilaria beccariana van Tiegh.	gaharu (I), eaglewood, agarwood (E)		Incense
Thymelaeaceae	Aquilaria filaria (Oken.) Merr.	gaharu (I), eaglewood, agarwood (E)		Incense
Thymelaeaceae	Gonystylus bancanus (Miq.) Kurz.	ramin (I)		Incense
Thymelaeaceae	Wikstroemia tenuiramis Miq.	gaharu cengkeh (I)		Incense
Urticaceae	Poikilospermum suaveolens (Blume) Merr.	mentawan (I)	16	Tea