POTENCY OF RAMIN (*Gonystylus bancanus* Kurtz.) AND OTHER COMMERCIAL SPECIES IN PEAT SWAMP FOREST MANAGED WITH TPTI SILVICULTURAL SYSTEM IN BAGAN, RIAU

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ABSTRACT

Ramin (*Gonystylus bancanus* Kurtz.) is one of the tree species in peat-swamp forest that is endangered due to excessive exploitation. The objective of this research was to assess the potency of ramin and other commercial tree species in primary and logged over peat-swamp forests at Bagan, Riau. The tree stands were inventoried in primary forest of the 2004 and 2006 Annual Work Plan (RKTs) and in the 1997 and 2001 RKTs managed with Indonesian Selective Cutting and Planting (TPTI) silvicultural system. The result showed that ramin in Bagan peat-swamp forest was not evenly distributed. The total number of ramin in tree stage in primary forests was fewer than that in logged over forests. The total number of ramin species at tree stage in primary forest was between 4.5 and 5 trees ha^{-1} with the important value index (IVI) of 10.3 to 12.0%, whereas the one at logged over forest were between 2.5 and 15 trees ha^{-1} with the IVI indices of 7.9 to 20.4%. Commercial species of swamp meranti *(Shorea uliginosa* and *S. teysmaniana)* and balam/suntai or *(Palaquium* spp.) were dominant at tree stage both in the primary and the logged over forests. Enrichment in logged over forests is not needed since the total number of seedlings and saplings is enough. The total number of potential core trees in logged over forests was enough for the next cutting cycle. The effort that must be done in logged over forests is to protect them from illegal logging.

Keywords: potency, ramin (*Gonystylus bancanus* Kurtz.), commercial tree species, peat-swamp forest, TPTI

I. INTRODUCTION

Tree species exploited by many people in peat-swamp forest is ramin (*Gonystylus bancanus* Kurtz.). Ramin wood is included as attractive wood with the price higher than meranti. The price of ramin moulding recently is between US \$ 675 and US \$ 750 m^{-3}. Therefore, many ramin trees at peat-swamp forest in Sumatera and Kalimantan were cut. Ramin potency at Teluk Umpan peat-swamp forest Central Kalimantan before exploitation was 45 trees ha^{-1}, 10 poles ha^{-1}, 200 saplings ha^{-1} and 16,000 seedlings ha^{-1}. One year after cutting, no tree and pole, but only 6,000 wold seedlings ha^{-1} were found (Daryono, 1996). This condition showed that ramin trees with the stem diameter of less than 20 cm were also then cut. Since ramin trees in natural forest have been scarce, the species were grouped in Appendix II following the *Convention on International Trade of Endangered Species of Wild Fauna and Flora (CITES)* in 2005 (Suhartono and Mardiastuti, 2002).

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Ramin and other commercial trees potency in peat-swamp forest are large enough. However, the biodiversity and yearly volume increment of trees in peat-swamp forest are generally lower than those in dry land of tropical rain forest. Some trees in peat-swamp forest with stem diameter more than 50 cm have trunk with hole inside the wood. That is the reason why the minimum stem diameter of commercial trees which can be cut in Selective Cutting and Planting System (TPTI) at peat-swamp forest is 40 cm. Actually, TPTI's silvicultural system is appropriate for tropical rain forest which consists of many species and various age classes, however because some forest concession right holders (Hak Pengusahaan Hutan=HPH) were not obeying the rule of TPTI, the continuity of wood production was not guaranted (Direktorat Produksi Hasil Hutan, 2000). Some commercial tree species such as ramin and eboni have been scarce in the forest. The scarcity of ramin in Tangkiling and Sampit (Central Kalimantan) was reported by Sutisna *et al.* (1988), and in Teluk Umpan (Central Kalimantan) by Daryono (1996).

The purpose of the paper was to inform ramin and other commercial trees potency at Bagan, Riau peat-swamp forest which was managed by one HPH permited to exploit ramin trees in certain extractable amount. This research hopefully could be used for evaluation in the implementing of TPTI system at peat-swamp forest in Riau.

II. METHODOLOGY

A. Time and Research Location

The research was carried out in December 2003 to October 2004 at Bagan Forest's Sub District, Dumai Forest District, under Riau Province Forest District. The study area was located between 100°48' - 101°13' WL and 1°49'- 2°18'NL. The soil types were Organosol and Gley Humus. The elevation was about 0 - 25 m above sea level. Average annual rainfall was 2,637 mm with "A" climate type according to classification by Schmidt and Ferguson. The highest rainfall occurred between November and December, and the lowest rainfall between March and July. The study area was peaty with the depth of peat more than 2 m. The location was inundated between 5 and 40 cm in wet season and not inundated in dry season.

B. Method

Inventory in 2004 and 2006's Annual Work Plan (Rencana Karya Tahunan=RKT) primary forest, and in 1997 and 2001 logged over forest was done twice in the year 2003 and 2004. Each forest area was inventoried by using two observation lines. Each observation line had the size 20 m x 500 m, consisting of 25 observation plots. The distance between observation lines in a forest area was 100 m.

Evaluation on biodiversity and natural regeneration were done by making plots with different sizes. Observation plot provided for tree stage (stem diameter more than 20 cm) was 20 m x 20 m, pole stage (stem diameter 10 - 19 cm) was 10 m x 10 m, sapling stage (stem diameter less than 10 cm, height more than 1.5 cm) was 5 m x 5 m and seedling stage (height less than 1.5 m) was 2 m x 2 m.

Parameters measured were tree height at crown base, stem diameter at 1.3 m above the ground or 20 cm above buttres root, and total number and species of trees, poles, saplings, and seedlings in one hectare.

C. Data Analysis

The leaves and twigs of trees which their botanical name could not be identified were taken for determination in Bogor. The tree species were groups in their particular categories, i.e. ramin, other commercial species, and non commercial species based on 1992 Forestry Manual (Anonymous, 1992). To calculate value of density, frequency, dominancy and important value index (IVI) were determined with the formula of Curtis and Mcintosh (Soerianegara and Indrawan, 1978) was used as follow:

- Density = total species / total area
- Relative density = (density of one species / density of all species) x 100 %
- Frequency = total plots of one species found / total plots of all species
- Relative frequency = (frequency of one species found / frequency of all species) x 100%
- Dominancy = covered area of one species / total plot area
- Relative dominancy = (dominancy of one species / dominancy of all species) x 100%
- Important value index (IVI) = relative density + relative frequency + relative dominancy
  For seedling and sapling stages IVI calculation was based on relative density and relative frequency.

Stand potency was calculated by summing total volume of each individual tree per hectare. Tree volume was calculated by the equation:

Tree volume = $n/4 \times (D/100)^2 \times T \times 0.5495 \times 1\ m^3$

D = stem diameter at 1.3 m or 20 cm above buttres root

T = height of trunk at crown base

0.5495 = stem form factor

Observation and calculation data were tabulated and analysed descriptively.

III. RESULT AND DISCUSSION

A. Species Composition and Domination

Species composition in the research area was dominated by commercial tree species. Of the 42 species found in study area, 30 were commercial trees including ramin trees, while the other 12 were lesser known species (Appendix 1). After exploitation in 1997, three species were lost compared to the species in the 2004 RKT primary forest. However, that condition was not to be a problem because based on Matius study in Batu Ampar (1995) cited by Ernayati and Yuliaty (2004), before exploitation primary forest consisted of 108 tree species, but in the 20 years-logged over forest the number of species increased to 114 species.

Calculation result of IV index indicated that seedling stage in 2004 RKT primary forest was in succession and dominated by milas (55.2%), balam (31.9 %) and pasir-pasir (19.2%), sapling stage was dominated by pasir-pasir (24.6%), arang-arang (20.3%) and balam (19.9%), pole and tree stages were dominated by meranti batu (52.5%) and balam (33.6%).

Regeneration at seedling stage in 2006 RKT primary forest was dominated by kelat (37.0%) and pasir-pasir (19.9%), sapling stage by medang (21.8%), pasir-pasir (19.7%) and balam (18.8%), pole stage by jambu-jambu (91.0%) and balam (33.7%), tree stage by jambu-jambu (45.3%), balam (43.4%) and meranti batu (40.8%). Regeneration at seedling stage in 2001 logged over forest was dominated by milas (82.2%) and timah-timah (18.0%), sapling stage by jambu-jambu (25.4%) and arang-arang (17.0%), while at pole and tree stages was by suntai (37.0%), meranti batu (36.1%) and ramin (22.3%). Natural regeneration at seedling stage in 1997 logged over forest was dominated by balam (57.1%), pasir-pasir (31.3%) and milas (31.2%), sapling stage by pasir-pasir (36.4%) and balam (20.5%), while at pole and tree stages was by balam (35.0%) and meranti batu (34.5%).

Compared to ramin at Teluk Umpan in the peat-swamp's primary forest, Central Kalimantan (Daryono, 1996), the potency of ramin at Bagan's peat-swamp primary forest Riau was only one ninth. However, after exploitation with TPTI the total number of ramin trees at Bagan was still between 2.5 and 15 trees ha^{-1} (IVI = 7.9 - 20.4%) (Appendix 2), whereas at Teluk Umpan, ramin at pole and tree stages could not found anymore. This is because forest concession right holder did not know that ramin species have included in Appendix III CITES in 1996; therefore, all pole and tree stages of ramin were cut at Teluk Umpan. This selective cutting manner disobeyed TPTI regulation, which only allows to cut the trees with minimum trunk diameter of 40 cm. Ramin exploitation at Bagan forest applied TPTI and CITES regulations, by leaving several ramin trees as potential core and mother trees.

The total number of ramin trees in the 2001 logged over forest (16 km from logpond) was 15 trees ha^{-1}, whereas in the 1997 logged over forest (6.5 km from logpond) was only 2.5 trees ha^{-1}. There was a tendency that the closer the distance to the coast, the fewer the number of ramin trees, possibly because of increasing thickness of peat. This opinion was supported by Istomo's observation result conducted on the same area (personal comm in 2003).

The number of natural regeneration seedlings per hectare in primary and secondary forest was a lot. In the first inventory (2003) the number of seedlings ha^{-1} in primary forest was 28,350, larger than those in the 1997 logged over forest (20,500 seedlings). But in the second inventory (2004), the number of seedlings in primary forest were fewer than those in the 1997 logged over forest (Table 1). It was because in logged over forest, part of the area opened up, therefore, more sun light especially red light spectrum could reach co-dominant trees which can induce flowering process (Salisbury and Ross, 1992). In logged over forest, light intensity reaching ground was larger thereby enabling to stimulate germination of seeds on the ground. The more sunray reach the ground, the better the stimulation of wild seedlings to grow faster, consequently the total number of saplings in logged over forest was larger than those in primary forest (Table 1). The number of ramin seedlings in primary forest was between 0.8 and 2.5% of the total number of seedlings, whereas in sapling stage was between 1.9 to 2.5% of the total number of saplings. The existence of ramin seedlings at Bagan's peat-swamp forest was much less than those of seedlings at Teluk Umpan peat-swamp forest which have ramin seedlings 16,000 ha^{-1} or 69.6 % of the total seedlings. Total number of ramin saplings at Teluk Umpan were 200 ha^{-1} or 7.5 % of total saplings (Daryono, 1996).

The total number of wild seedlings at ex-railway track was not enough (10,275 seedlings), and most of them were pioneer species e.g. *Macaranga* spp, *Eugenia* spp. and *Ilex macrophylla* Hook f. seedlings of commercial species which were cut in selective cutting system such as ramin, durian burung, balam and suntai were not found at this area except meranti batu (Table 1). Therefore, ex-railway track should be rehabilitated by planting semi tolerant seedling species (ramin, balam or suntai).

Because only small light intensity from sunray reached the ground, many wild seedlings were dead in primary forest, consequently the total number of saplings was fewer than that in logged over forest. Considering that the total number of natural seedlings and saplings in the 1997 and 2001 logged over forests was enough, it was not necessary to enrich these areas by planting. Rehabilitation can be done at ex-landing construction, ex-railway track and ex-skid-trail construction. The species that should be planted were the ones which had been exploited. Open area could be planted with intolerant species, whereas medium shading area could be with semi-tolerant species.

Table 1. Number of seedlings and saplings in primary forest of the 2004's RKT and the 2006's RKT, logged over area of 1997, and ex- railway track

No.	Forest Area	Number hectare $^{-1}$			
		Seedling of 2003	Seedling of 2004	Sapling of 2003	Sapling of 2004
1.	Primary forest of the 2004 RKT	28,350	35,950	2,856	2,752
	Ramin	50	300	56	64
2.	Primary forest of the 2006 RKT	*	33,550	*	3,296
	Ramin	*	850	*	64
3.	1997 Logged over forest	20,500	37,100	3,432	3,494
	Ramin	450	800	32	32
4.	2001 Logged over forest	12,200	**	3,752	**
	Ramin	50	**	16	**
5.	Ex-railway track	-	10,275	-	*
	Ramin	-	0	-	*

Notes : - = railway track exist, not inventoried;
* = railway track was not existed yet, not inventoried
** = railway track had been disclosed, not inventoried

B. Wood Potency

The inventory result showed that the total number of trees with stem diameter ranging between 20 and 39 cm and those with stem diameter more than 40 cm in the 1997 logged over forest were fewer than that in the 2001 logged over forest. It maybe because the exploitation in 1997 was more intensive than that in 2001, since the location of the 1997's secondary forest (6.5 km from log-pond) was nearer than that of the 2001's secondary forest (16 km from log-pond), so the cost of wood transportation was cheaper. In location far away from log-pond, only tree species with high value wood were cut to compensate the cost of transportation.

The wood potency of commercial species in the 2004 RKT on primary forest with stem diameter greater than 40 cm was more than 140 $m^3 ha^{-1}$ and in fact larger than that in the 2006 RKT primary forest (Table 2), because several meranti batu with stem diameter of larger than

100 cm were found in the 2004 RKT primary forest. Based on this forest condition, tree volume exploited and extracted by TPTI system in the 2006 RKT on primary forest should be less than that in the 2004 RKT on primary forest. Meranti batu trees revealed their dominance in primary and secondary forests in Bagan Sub District. It was recommended that meranti batu with stem diameter of more than 100 cm should be prioritized to be cut to give opportunity for co-dominant trees to grow faster.

The potency of the 2001 and 1997 logged over forest was enough for the next cutting cycle. The total number of potential core trees in the 2001 and 1997 logged over forest was far greater than that in the TPTI regulation (25 trees ha^{-1}). Measurement on average trunk diameter increment of commercial trees annually was 0.55 cm, it means that logged over forest could produce wood volume at least similar to that of the first cutting. Moreover, if potential core trees were added with trees of more than 40 cm stem diameter, the wood production for the next cutting cycle may be larger. The important thing may be done is that the logged over forest must be protected from illegal logging.

Table 2. Total number of trees and stand volume ha^{-1} in the 2004 RKT and 2006 RKT on primary forests, and the1997 and 2001 logged over forests

No.	Forest condition	Diameter (20 - 39 cm)		Diameter > 40 cm	
		Total number (tree/ha)	Volume (m^3/ha)	Total number (tree/ha)	Volume (m^3/ha)
1.	2004 RKT primary forest				
	a. Ramin	2.5	2.56	2.5	6.45
	b. Other commercials	68.5	43.08	36.5	136.55
	c. Others	23.5	11.57	8.0	12.04
2.	2006 RKT primary forest				
	a. Ramin	2.5	1.69	2.0	6.57
	b. Other commercials	105.0	46.56	30.0	53.36
	c. Others	20.0	7.03	6.0	5.82
3.	1997 Logged over forest				
	a. Ramin	0.5	0.46	2.0	4.54
	b. Other commercials	72.0	39.96	22.5	58.31
	c. Others	18.0	9.45	8.5	19.56
4.	2001 Logged over forest				
	a. Ramin	12.5	12.05	2.5	7.40
	b. Other commercials	82.5	50.31	25.0	71.00
	c. Others	15.5	8.26	1.0	2.35

Ramin species with stem diameter of more than 20 cm in primary forest was only between 4.5 and 5 trees ha^{-1}, whereas that in the 2001 logged over forest was 15 trees ha^{-1}, but in the 1997 logged over forest was 2.5 trees ha^{-1} (Table 2). This condition showed that ramin trees in Bagan peat-swamp forest was not evenly distributed. Rehabilitation of ex-railway track and ex-skid-trail construction with ramin seedlings could enrich forest for the third rotation. Ramin seedlings are not suitable for rehabilitation in open area such as ex-landing construction. Observation in Bagan forest showed that ramin seedlings planted on open area had not grown shoots for 10 months. Generally, the growth of ramin in juvenile stage is slow. Measurement of ramin plantation at 5 years old on ex-landing construction area in Teluk Umpan, Central Kalimantan showed that the height and stem diameter increment were 20.01 cm $year^{-1}$ and 0.27 cm $year^{-1}$, respectively (Daryono, 1996).

IV. CONCLUSIONS AND RECOMMENDATIONS

A. Conclusions

1. The total number of ramin trees in Bagan peat-swamp forest, Riau varied and had a tendency that the farther the distance to the coast, the less the number of ramin trees. Total number of ramin trees in primary forest was between 4.5 and 5 trees ha^{-1} (IVI = 10.3 - 12.0%), whereas that in logged over forest was between 2.5 and 15 trees ha^{-1} (IVI = 7.9 - 20.4%).
2. Ramin was one of the dominant tree species in the 2001 logged over forest, whereas swamp meranti (*Shorea uliginosa* and *S. teysmaniana*) and balam/suntai (*Palaquium* spp.) trees were dominant in the primary and secondary Bagan peat-swamp forests.
3. Commercial tree volumes which can be exploited using the TPTI system at Bagan for the 2006 RKT were less than those for the 2004 RKT.
4. The total number of potential core trees afforded by commercial species in logged over forest was more than enough for the next cutting cycle, as long as the forests can be protected from illegal logging.
5. The total number of seedlings and saplings in logged over forest were enough, so it was not necessary to enrich this area. Rehabilitation is needed at ex-landing construction, ex-railway track and ex-skid-trail construction areas by planting commercial tree seedlings.

B. Recommendations

1. Seedlings for rehabilitation should be with commercial species which had been exploited. Ramin and balam/suntai seedlings can be planted under medium intensity tree shade, whereas meranti batu and durian burung can be planted on ex-landing construction area.
2. It is needed to leave several ramin species as potential core or mother trees in logged over forest, because this species had been scarce at Bagan's peat-swamp forest and included in Appendix II, CITES recently.

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Appendix 1. List of tree species in Bagan's peat-swamp forest, Riau

No.	*Local name*	*Family*	*Botanic name*
1.	Arang-arang*	Ebenaceae	*Diospyros* spp.
2.	Asam-asam*	Sapotaceae	*Palaquium ridleyi King & Gamble.*
3.	Balam*	Sapotaceae	*Palaquium* spp.
4.	Bintangur*	Guttiferae	*Calophyllum soulattri* Burm.
5.	Cabe-cabe	Celastraceae	*Bhesa robusta* (Roxb.) Ding Hou
6.	Darah-darah*	Myristicaceae	*Myristica viliosa* Warb.
7.	Durian burung*	Bombacaceae	*Durio carinatus* Mast.
8.	Geronggang*	Hypericeae	*Cratoxylon arborescens* Bl
9.	Huni	Euphorbiaceae	*Antidesma bunins* (L.) Spring
10.	Jangkang	Annonaceae	*Xylopia* spp.
11.	Jambu-jambu*	Myrtaceae	*Eugenia* spp.
12.	Kelat*	Myrtaceae	*Eugenia* spp.
13.	Kempas*	Caesalpiniaceae	*Koompassia malaccensis* Maing.
14.	Kenari	Burseraceae	*Dacyodes* spp.
15.	Keranji*	Leguminosae	*Dialium indium* L.
16.	Kopi-kopi	Euphorbiaceae	*Chaetocarpus castanocarpus* Roxb.Thw
17.	Laban*	Verbenaceae	*Vitex* spp.
18.	Mahang*	Euphorbiaceae	*Macaranga* spp.
19.	Malam-malam*	Myrtaceae	*Eugenia* spp.
20.	Mangga*	Anacardiaceae	*Mangifera* spp.
21.	Manggis	Guttiferae	*Garcinia celebica* L.
22.	Medang*	Lauraceae	*Litsea* spp.
23.	Mengkal udang	Lauraceae	*Alseodaphne.* spp.
24.	Meranti batu*	Dipterocarpaceae	*Shorea uliginosa*
25.	Meranti bunga*	Dipterocarpaceae	*Shorea teysmaniana* Dyer.
26.	Milas	Melastomataceae	*Memecylon crassifolium* Bakh.
27.	Nangka-nangka	Moraceae	*Artocarpus teysmanii* Miq.
28.	Nyatoh*	Sapotaceae	*Palaquium* spp.
29.	Pala hutan	Myristicaceae	*Myristica* spp.
30.	Parak linggau	Meliaceae	*Aglaia ignea* Valeton ex K. Heyne
31.	Pasir-pasir	Icacinaceae	*Urandra scarpiodes* O.Ktse
32.	Pauh	Anacardiaceae	*Campnosperma* spp.
33.	Pisang-pisang	Rhizophoraceae	*Kandelia condell* Droce
34.	Pulai*	Apocynaceae	*Alstonia pneumatophora* Back
35.	Punak*	Theaceae	*Tetrameristra glabra* Miq.
36.	Ramin*	Thymeliaceae	*Gonystylus bancanus* Kurtz.
37.	Simpur*	Dilleniaceae	*Dillenia* spp.
38.	Slumar	Boraginaceae	*Cordia suchadata* Lamb
39.	Suntai*	Sapotaceae	*Palaquium* spp.
40.	Terentang*	Anacardiaceae	*Campnosperma curiculata* Hlef.
41.	Terpis*	Annonaceae	*Polyalthia hypoleuca* Hook f.
42.	Timah-timah	Aquifoliceae	*Ilex macrophylla* Hook f.

Note: * commercial species (Anonim, 1992)

Appendix 2. Number of species and important value index (%) per hectare for ramin (a) and other commercial species (b, c, d, and e) in Bagan's peat-swamp forest, Riau

No.	Forest	Seedling		Sapling		Pole		Tree	
		N	IVI	N	IVI	N	IVI	N	IVI
1.	2004's RKT forest								
	a.ramin	300	3.3	64	5.5	0.5	6.0	5.0	1.3
	b. meranti rawa	1,450	11.0	72	6.2	2.0	30.4	25.0	35.4
	c. durian burung	0	0.0	0	0.0	0.5	6.2	2.0	6.7
	d. balam/suntai	5,350	10.4	272	17.9	1.5	21.3	19.5	33.1
	e. other commercials	17,050	104.1	1,288	80.1	10.5	122.3	67.5	162.9
2.	2006's RKT forest								
	a. ramin	850	5.3	64	4.6	2.0	11.5	4.5	12.0
	b. meranti rawa	2,300	14.4	144	10.5	4.0	23.3	26.0	56.4
	c. durian burung	50	0.6	8	0.6	0.5	2.9	3.0	5.2
	d. balam/suntai	1,500	8.1	392	18.3	6.0	33.7	26.5	43.4
	e. other commercials	17,450	101.0	1,488	93.5	32.5	178.5	79.5	133.5
3.	1997's logged over forest								
	a. ramin	800	6.1	32	2.6	0.5	17.3	2.5	7.9
	b. meranti rawa	2,600	17.9	288	15.1	0.0	0.0	22.5	56.0
	c. durian burung	50	0.6	8	0.7	0.0	0.0	1.0	2.8
	d. balam/suntai	7,450	33.4	358	20.4	2.0	22.0	20.0	20.1
	e. other commercials	16,550	76.1	1,128	67.5	15.5	150.1	51.0	138.6
4.	2001's logged over forest								
	a. ramin	50	1.7	16	1.2	0.0	0.0	15.0	20.4
	b. meranti rawa	100	2.1	144	9.1	0.0	0.0	25.0	33.9
	c. durian burung	0	0.0	0,0	0.0	0.0	0.0	0.0	0.0
	d. balam/suntai	50	1.7	120	8.1	0.0	0.0	22.5	30.5
	e. other commercials	4,700	96.0	1,240	123.4	36.0	48.8	60.0	81.4

Notes : RKT = Annual Work Plan
N = Number of species
IVI = Important Value Index (%)