Improving productivity
of
Indonesian rubber based agroforestry systems

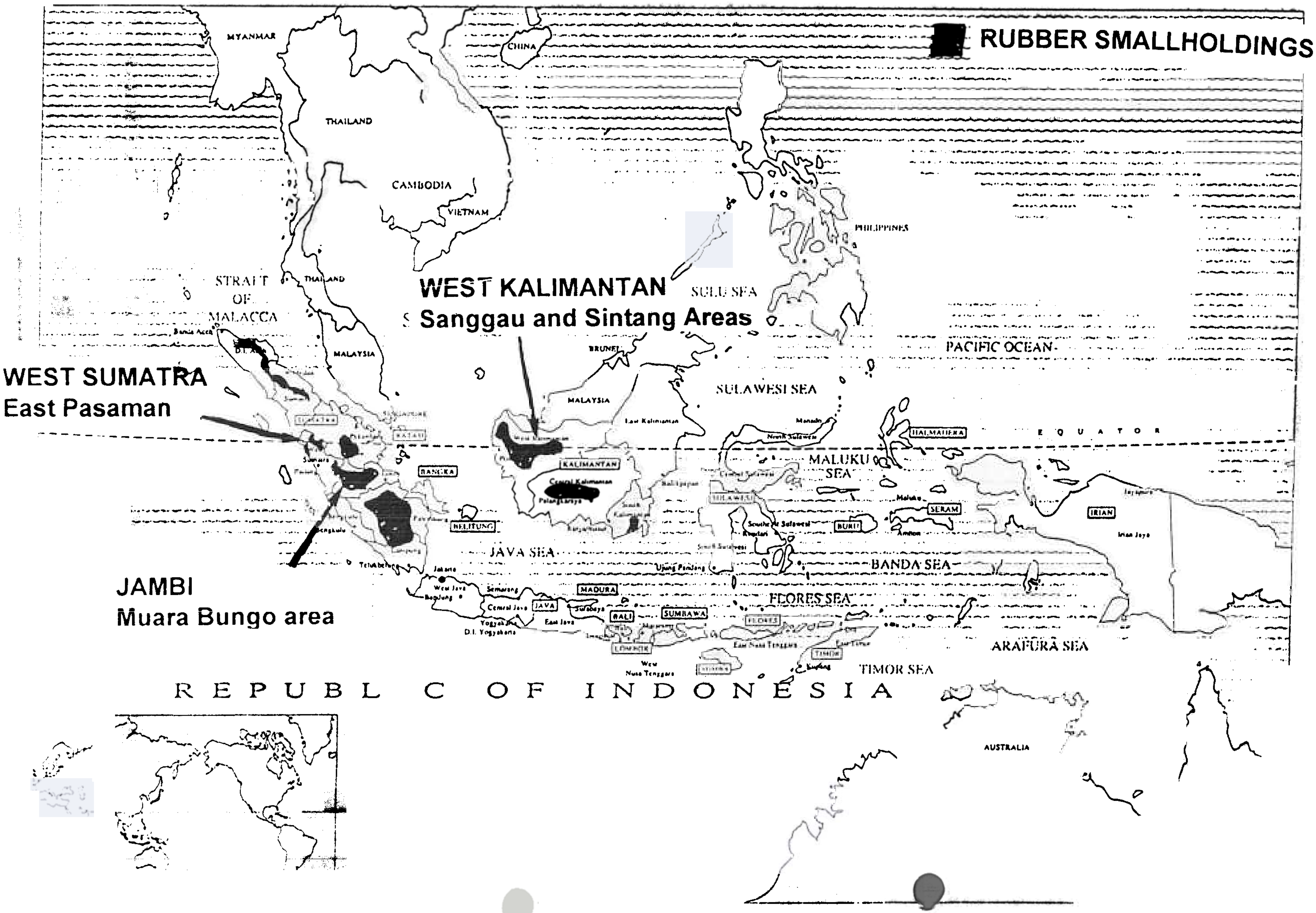
Rubber Agroforestry Systems (RAS) as a challenge for the improvement of rubber productivity for smallholder through sustainability, biodiversity and environment.

Introduction and financial analysis of RAS systems

Eric Penot
May 1996

Smallholder Rubber Agroforestry Project/GAPKINDO/CIRAD-CP/ICRAF

MAIN AREA OF RUBBER SMALLHOLDINGS AND SRAP/RAS EXPERIMENTATION SITES



MAP OF INDONESIA

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Introduction and financial analysis of RAS systems

Note : this document aims to present, through a simple calculation over the complete lifetime of these rubber based systems, the productivity and return to labour of various rubber based cropping patterns. Some of the components of these calculations are assumptions as these systems, in particular RAS are still in experimentation with farmers.

INTRODUCTION

After plywood, rubber is Indonesia's second most important non-oil export commodity. About 12.5 million people in the country are involved in the production, processing and marketing of rubber. Rubber is also the main source of income for smallholder farmers on the low-lying and infertile plains on the islands of Sumatra and Kalimantan. Smallholders produce 73% of Indonesia's total output of rubber, and approximately 1.3 million farm households rely on rubber production for their income. More than two-thirds of these households still grow 'jungle rubber' with unselected rubber *(Hevea brasiliensis)* in an extensive agroforestry system that covers more than 2.5 million hectares. But farmers' average yield of rubber in this system is low—593 kg per hectare compared with 1065 kg/ha on private rubber estates and 1311 kg/ha in government estates (DGE 1993). The low production is caused by a lack of improved planting material. Farmers still use unselected rubber seedlings they get from the natural forest in their jungle rubber. The majority do not have access to improved high-yielding planting material, technical information or credit, all of which have been included in technical development packages of the past two decades[1] (Gouyon 1989).

Tyre industries, which use 70% of the total natural rubber produced, have rigorous standards that buyers apply when purchasing rubber from producers. Raw rubber must be clean, correctly coagulated and conserved and have a good consistency before it is processed into rubber that will be able to compete on the international market. More productive rubber systems will help the smallholders meet these standards, and benefit from a quality pricing policy (Gouyon and others 1989).

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[1] Rubber development projects such as TCSDP (Tree Crop Smallholder Development Project) with local farmers, or NES (Nucleus Estate Shemes) in transmigration areas

TABLE 1

Comparison of bird diversity

	primary forest Mua/Kru/Man	rubber agrof. Muarabungo	damar agrof. Krui	durian agrof. Manunjau
observed richness	179	105	92	60
average richness per sample (n. spp.)	26.4	18.5	15.4	15.1
rare species (%)	79.9	72.3	75	62.5

Source: Thiollay, 1994

Rare species are those which account for less than 1% of the total population

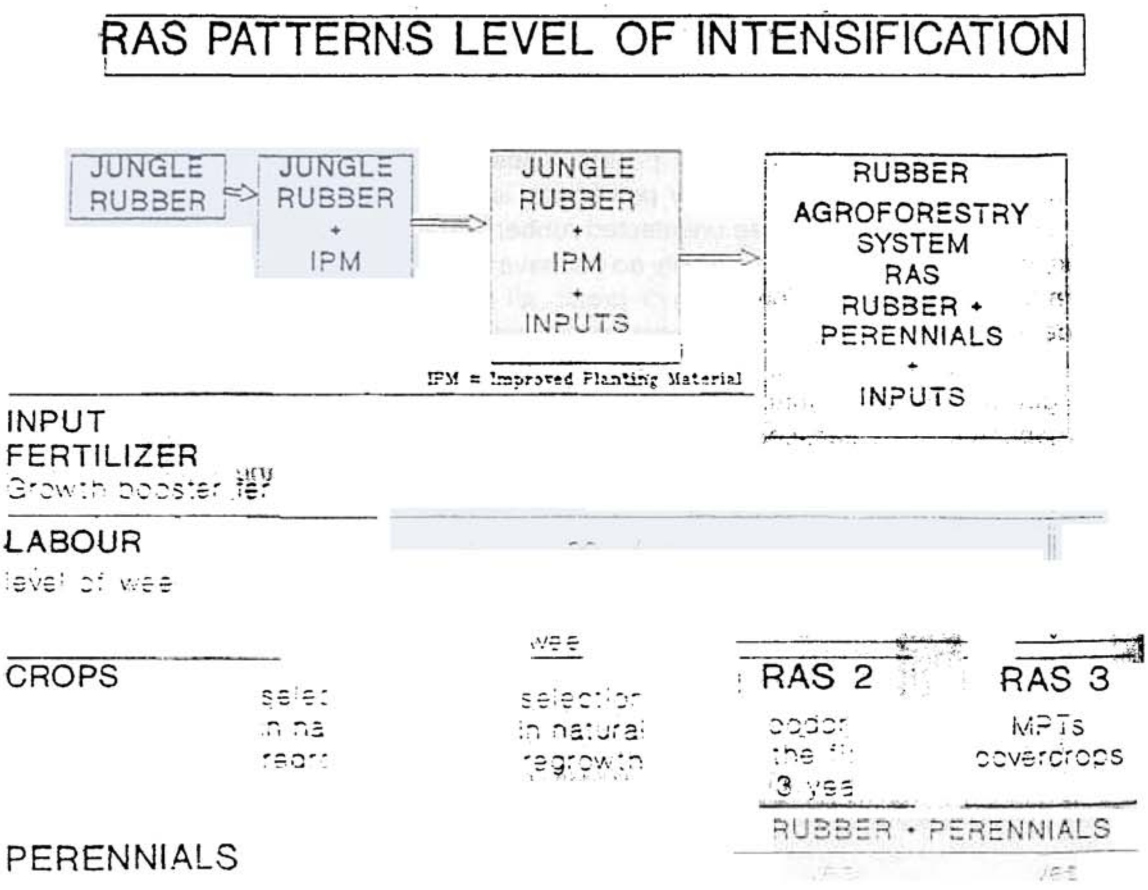
Comparison: species richness and abundance

	number of species			frequency		
	rubber estate	rubber agro-forest	primary forest	rubber estate	rubber agro-forest	primary forest
trees	1	92	171	28	247	258
lianas	1	97	89	5	228	219
tree seedlings	0	26	45	0	170	72
epiphytes	2	28	63	2	51	261
herbs	2	23	12	* 2000	217	84
total	6	266	382	2035	913	897
trees (except rubber)	0	91	171	0	189	258
total (except rubber)	5	265	382	2007	855	897

samples: 100 m transect-line; all plants past seedling stage recorded

* estimated number of herbs: about 1000 individuals for each species

TABLE 2



In general, low labour costs in Indonesia[2] enable the country to compete well with Malaysia and Thailand, two other rubber producing countries where improved planting material has been made available to farmers since the 60's, but where wage levels are higher. However, the low productivity of rubber and the quality of the rubber produced in these systems are major issues for farmers who manage jungle rubber agroforestry systems in Indonesia (Gouyon and others, 1993).

Jungle rubber agroforestry

The jungle rubber system is a low-input agroforestry system, in which rubber competes with the regrowth of the natural forest. In the past, people who grew perennials on land could lay claim to it, so rubber agroforestry systems were, and still is, a means of acquiring land. Furthermore, the system is inexpensive and requires little labour to establish and maintain (Gouyon 1993).

After an area is cleared by slashing and burning, rice is planted for the first year or, more rarely, two. After that, rubber is planted along with a variety of other useful trees that produce fruit, nuts, timber and rattan as well as a wide range of other side-products (medicinal plants...). The secondary forest associated with rubber is biologically diverse, and the forest-like environment makes for good soil fertility and quality and watershed management (de Foresta 1992a). The biodiversity, plants as well as animals, is high compared to that of plantations and for some components close to that of primary forests. "Agroforests are extrelemy close to natural forest formations in their dominance, diversity and origin of most of their species. As with natural forests, agro-forests can be considered as sustainable in the long term....The rubber agroforests is the closest to natural forest in term of birds species."(G Michon and de Foresta H., 1995). The table 1 reflects the biodiversity of rubber agroforest. Jungle rubber has been in the past the best sustainable alternative to swiden agriculture and enable an important spontaneous transmigration, providing an excellent income opportunity without notable degradation of the environment.

On the whole, the rubber agroforestry systems are sustainable alternatives to the original slash-and-burn process as it can provide to farmers a reliable weekly source of income for more than 30 years for rubber, the main economical driving force of the system, and up to 60 years for fruits and timber. The sources of income—rubber, fruit, nuts and other tree products—are diverse and the system can easily be replaced by a new plantation when it surpasses maturity, or let as a fruit/timber based agroforest. It can also be converted into a pure-standing rubber plantation or it can be managed as a fruit and timber agroforest, such as the 'tembawang' system in western Kalimantan (see characteristics of associated plants in table 4).

The main challenge for researchers is to test various kinds of improved planting materials and appropiate levels on inputs and labour to see which grow and produce best in such agroforestry systems, and which are most appropriate—and affordable—for smallholders (Barlow 1993, Penot 1994).

Improved planting material comes in two forms. There are the clones that have been selected by cross-breeding or chosen from one superior tree and multiplied by grafting. These homogeneous and high-yielding clones are costly, between 500/700 rupiahs for a grafted stump to 1200 rp/plant in polybag in 1996.They also require more

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[2] Minimum daily wage is 1.5 US $ in Indonesia, for more than 3 US $ in Thailand and above 6 US $ in Malaysia

TABLE 3

SRAP/GAPKINDO/ICRAF

RAS TRIALS CHARACTERISTICS and DISTRIBUTION IN WEST KALIMANTAN AND JAMBI PROVINCES

DATE / 10/2/1996

Trial code	Trial characteristics	Type	plot size m²	number of plots per rep main and sub treatment	area per farm/replication in m²	location province	location village	DATE OF planting	Number of trials	total number of farms/rep	Total area of trial in ha	area per farm or location in ha
Jungle rubber with rubber clone and minimum level of weeding in the row.												
RAS 1/1	Level of management DP = 550 rubber/ha	OFT	1,000	4 3 weeding + control TCSDP density	4,000	KALBAR	KOPAR	1995	1	3	1.20	0.40
					4,000	KALBAR	ENKGAYU II	1996	1	3	1.20	0.40
	DP = 550 rubber/ha	OFT	1,000	4 3 weeding + control TCSDP	4,000	JAMBI	Muara buat +rantau pandan	1996	1	6	2.40	0.40
RAS 1/2	DP = 750 rubber/ha	OFT	1,000	3 (weeding)	3,000	KALBAR	ENKGAYU II	1996	1	3	0.90	0.30
Rubber + associated trees + rice intercropping : treatments on associated trees combination												
RAS 2.1	Tree group 5 treatments	OFT	1,000	5	5,000	KALBAR	Trimulia	1996	1	6	3.00	0.50
	Tree group 7 treatments + rice	OFT	1,000	7	7000	KALBAR	SPP sekadau	1996	1	1	0.70	0.70
Rubber + associated trees (farmers' mix) + rice intercropping : treatments on rice : variety + fertilization level												
RAS 2.2/rice	farmers' mix Medium density	OFT	500	9	4500	KALBAR	Sintang	1993	1	5	2.25	0.45
	farmers' mix high density	OFT	500	9	4500	KALBAR	Sintang	1993	1	4	1.80	0.45
	low density		500	9	4500	KALBAR	Trimulia	1996	1	3	1.35	0.45
Rubber + associated trees + palawijas in the inter-rows the first 5 years												
2/palaw	banana/cassava low density	OFT	4,500	1	4500	JAMBI	Seppungur	1996	1	3	1.35	0.45
	Palawija low density	OBS	4,500	1	4500	JAMBI	Muara Buat	1996	1	1	0.45	0.45
Rubber + associated trees + rice intercropping : treatments on associated trees combination + planting density												
RAS 2.3	associated trees planting density	OS Sembawa 1997	1,000	13 Tree group x planting density	13,000	SUMSEL	Sembawa 1997	???	1	3	3.90	1.30 on station
Rubber + cinnamon : (+ 2 treatments : rubber only + cinnamon only)												
RAS 2.5	Cinnamon normal spacing	OFT	1,000	3 pure standing + cinnamon only	3,000	JAMBI	MB RT	1996	1	3	0.90	0.30
Rubber + associated trees + FGT (fast growing pulp trees)												
RAS 3.1	Covercrops screening Observation plot	OBS	1,000	5	5,000	KALBAR	KOPAR	1995	1	1	0.50	0.50
RAS 3.2	Timber trees + covercrops	OFT	1,000	5	5,000	KALBAR	KOPAR	1995	1	3	1.50	0.50
RAS 3.3	associated trees + FGT	OFT	1,000	5	5,000	KALBAR	ENGAKYU II	1996	1	3	1.50	0.50
RAS 3.4	FGT only	OFT	1,000	5	5,000	KALBAR	TRIMULIA	1996	1	3	1.50	0.50
TOTA				PLOTS 85					TRIALS 17	REP/FARM 54	ha 26.4	

KALBAR = West-Kalimantan province
JAMBI : Jambi province
OFT : On-Farm Trial
OBS : observation plot
OS : On Station trial

labour for maintenance. However, clones double or even triple latex production over the unimproved rubber trees (average production of PB 260 is 1600/1800 kg/ha in TCSDP/South-Sumatra). 4 clones have been selected for RAS (table 5).

There are also the improved seedlings—clonal or polyclonal. Clonal seedlings are obtained from seeds collected under clonal rubber trees; polyclonal seedlings are those collected in a specific clonal garden with a variety of selected clones. These are relatively cheap, ranging from 20/30 rp for GT1 seedlings to 80/120 rp for BLIG[3] seeds, but their production potential is rather limited and should be tested in the agroforestry environment for BLIG in particular. This improved seedlings are also very heterogeneous, not particulary resistant to leaf disease and timber wood is less valuable than that of clones.

Supplying certified clonal planting material to smallholders is a major undertaking for development agencies. The goals are to raise rubber production from 500 kg per hectare in smallholder agroforestry systems to 1500 or 1800, as well as to increase yields of associated perennial crops in the systems, such as wood, fruit and rattan. Testing of improved planting material also includes assessment of rubber production with minimum inputs such as fertilizers, herbicide as well as labour...

The Smallholder Rubber Agroforestry Project from GAPKINDO/CIRAD-CP/ICRAF[4]

SRAP) research aims to use improved planting material to improve productivity of the rubber agroforestry systems, which can be established in pioneer and buffer zones, in degraded zones such as Imperata savannah as well as in zones where replanting is required (old jungle rubber in Riau, Jambi, South-Sumatra and Kalimantan).The objective is to identify the components of RAS which may be minimized in term of quantity but optimized in term of labour.

SRAP is using a participatory approach to do on-farm experimentation with three main kinds of rubber agroforestry systems (RAS) . Each is being tested for its suitability for local agro-ecological conditions, for labour and cost requirements and to determine the best level of intensification (table 2). The first (RAS 1) is similar to the current jungle rubber system, in which unselected rubber seedlings are replaced by clones selected for their potential promising adaptation[5]. These clones must be able to compete with the natural secondary forest growth; various planting densities and weeding protocols will be tested. This will identify the minimum amount of management needed for the system, a key factor for farmers whose main concern is also to maintain or increase labour productivity.

The second, RAS 2, is a complex agroforestry system (de Foresta 1992b) in which rubber and perennial timber and fruit trees are established after slashing and burning, at a density of 550 rubber and 92 other perennial trees per hectare. It is very intensive, with annual crops being intercropped during the first 3 or 4 years, with emphasis on improved upland varieties of rice, with various amounts of fertilization as well as dry season cropping such as groundnut. Several variation on crops combinations are being tested including foodcrops or cash crop as cinnamon. Several planting

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[3]BLIG = Bah Lias Isolated garden from London Sumatra estate in North-Sumatra (the only supplier of real polyclonal seeds in Indonesia).

[4]This research is implemented with collaboration of CIRAD, ORSTOM, UNESCO as well as GTZ and BPS/Sembawa as local partners.

[5]The selected clones are PB 260, RRIC 100, BPM 1 and RRIM 600

TABLE 5

Main characteristics of selected clones for RAS/OFT. Provinces with severe leaf disease risks (West-Kalimantan and West-Sumatra).

CLONE	*ADVANTAGES*	DISADVANTAGES
PB 260	*very good growth, very high yielding, very good shadowing, resistant to Colletotrichum. No stimulation required. Permit D3 or D4 exploitation system (save labor)*	susceptible to *Corynespora*, pink disease and TPD, exploitation system should be D3 or D4, not very adapted to D2. High risk with over stimulation or over-exploitation.
RRIC 100	*very good growth, very high yielding, very good shadowing, resistant to Colletotrichum and Corynespora. Adapted to D2. No stimulation required*	Average susceptibility to leaf *Phytophtora* and pink disease. Heavy canopy.
RRIM 600	*average growth, high yielding. The most planted clone in Thailand. Resistant to Colletotrichum.*	Susceptible to wind damage. Should be avoided in Riau and North-Sumatra. Susceptible to Oidium (no incidence in West-Kalimantan).
BPM 1	*good growth, very high yielding with a regular increase of production, very good shadowing, rlatively resistant to Colletotrichum and Corynespora. Adapted to D2 expotation system.*	Average susceptibility to *Phytophtora*. Average susceptibility to Oidium (no incidence in W-Kalimantan). Not widely grown, so not well known. Grafting is considered by farmers as difficult.

TABLE 4

MAIN CHARACTERISTICS OF TREES ASSOCIATED TO RUBBER IN RAS

TREE	USE: spice	gums resins latex	textile	wood TIMBER	fruits nuts	sugar products	medicine	stimulant	craft	vegetable	[illegible]	[illegible]	perfum	ornemental	miscellaneous fodder firewood [illegible]	environement oriented
PETAI	X			X			X			X					X	
CEMPEDAK			X	X	X		X			X					X	
PETAWAI																
KERANGI				X	X											
BEDARA				X	X		X	X			X					
TERAP		X	X	X	X		X		X		X					
PANDAN WANGI									X				X			
PANDAN PUNDAK			X		X		X		X	X				X		
DUKU				X	X		X					X				
RAMBUTAN				X	X		X	X			X					
MERANTI/DAMAR		X		X			X					X				
TANGKIL			X	X	X					X						
JENGKOL			X				X			X		X			X	
SUNGKAI				X			X							X		
TEK/JATI				X			X									
MAHONI/MAHOGANY		X		X			X									
GLIRICIDIA														X	X	X
LEUCEANA							X	X		X		X			X	X
GAHARU			X	X			X						X			
CULTIVATED RATTAN									X							
RATTAN MANAU									X							
ACACIA MANGIUM															X	X
CALLIANDRA															X	X
ALANG-ALANG			X				X	X	X						X	

Source : Economic plants of Indonesia, ORSTOM 1991