SMALLHOLDER RUBBER AGROFORESTRY PROJECT
(SRAP)

ANNUAL TECHNICAL REPORT 2000

RUBBER AGROFORESTRY SYSTEM (RAS)

ON-FARM EXPERIMENTATION IN INDONESIA

Prepared by Dominique BOUTIN

Associated Scientist ICRAF/CIRAD-CP
ICRAF Southeast Asian Regional Research Program
Jl CIFOR, Situ Gede, Sindang Barang, P.O.Box 161 Bogor 16001
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Smallholder Rubber Agroforestry Project (SRAP)
(Project implemented by Cirad- Icraf- Gapkindo- IRRI Sembawa)

Summary of main results in experiment network

The results obtained during the year 2000 confirmed that Rubber Agroforestry Systems (RAS) are valuable alternatives to the monoculture cultivation of rubber. Extension agencies have proposed models copying technologies from rubber estates such as intensive weeding, sowing of legume cover crops (LCC) and intensive use of inputs. This approach works if cheap credits or grants are given to farmers. Other farmers (outside development projects) cannot implement similar development due to lack of capital.

Three different Rubber Agroforestry Systems (RAS) were studied in three provinces of Indonesia: West Sumatra, Jambi and West Kalimantan. Growth performances are very encouraging, as, in most cases trials will be tapped before 6 years of age. RAS plots obtained similar performances than rubber in monoculture but at lower cost (less chemical inputs and labor).

The main feature of RAS is its easy acceptability by farmers, because the RAS follows current farmer practices but brings also some innovations. The different systems fits most conditions:

RAS 1: System close to the traditional jungle rubber: low cost approach but environmental benefits
RAS 2: Diversification of sources of income by association of food crops and fruit trees with rubber
RAS 3: A new approach to convert *Imperata* grasslands using fast growing trees between rows of rubber.

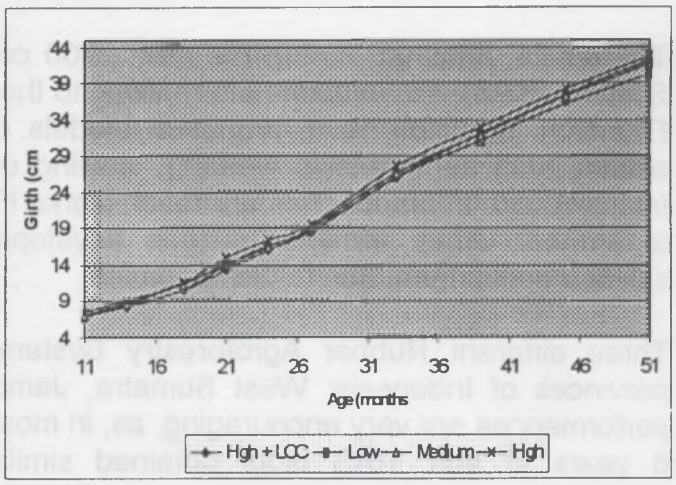
RAS 1 Trials

RAS 1 is established after a cultivation of upland rice. The main originality of the system is the use of **high yielding rubber clones** and the promotion of natural vegetation re-growth by limiting upkeep to the rubber row only. The natural vegetation in the inter-row drastically reduces labor requirements for weeding because rubber row only is weeded. The system have similarities with «*jungle rubber*» widely practiced by smallholders therefore, RAS 1 is expected to be easily adopted by farmers. The promotion and conservation of biodiversity in the system is an additional advantage giving to rubber an environment-friendly crop label.

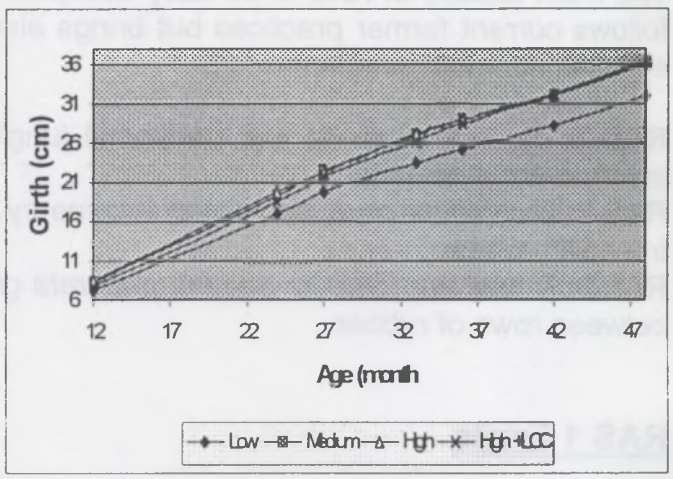
1. *Weeding intensity*

Trials RAS1.1a and b- West Kalimantan - RAS1.1 Jambi

Weeding rounds were conducted on the rubber row only to ensure a satisfactory growth of rubber. High frequency of weeding did not improve significantly rubber performances. The frequency of weeding must be decided according to prevalent vegetation. Four rounds of weeding per year during Year 1 and Year 2 are sufficient in fields free of *Imperata*.



In farms where *Imperata* or grasses are present, weeding must be more intensive during the two first years to prevent any growth delay on rubber. On the figure (left) it can be observed that low weeding intensity affect rubber growth if grasses or *Imperata* are present.



Consequently, for a successful implementation ,RAS 1 requires

- **Well-developed plants raised in polybags to obtain a fast initial growth.**
- **Weeding be properly performed at regular times (4 times a year).**
- **A vigorous re-growth of vegetation (trees and shrubs) to control grasses.**

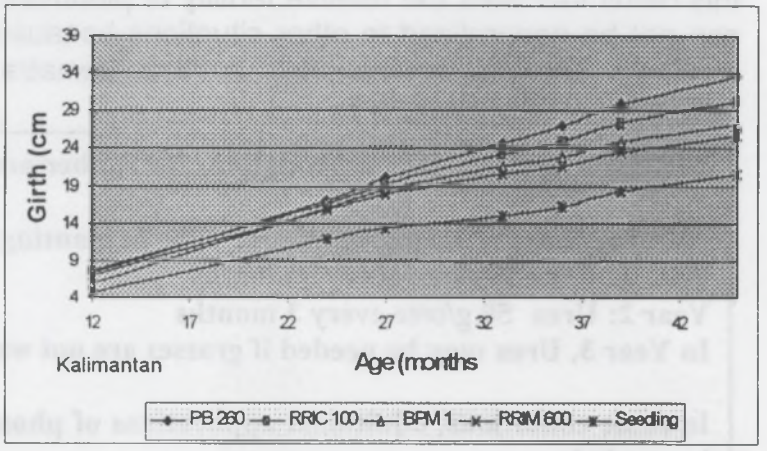
Trials, established in 1996 and using good planting material, developed well and they confirmed that:

- **Rubber growth performances with agroforest practices are similar to rubber monoculture condition.**
- **Natural vegetation helps the rubber growth by the effective control of grasses and noxious weeds like *Imperata*.**
- **The growth of young rubber plants is enhanced due to high soil moisture as in a young forest environment.**

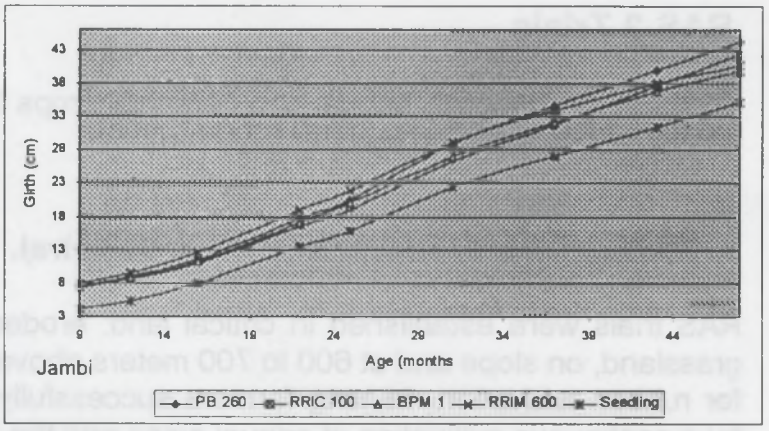
2. Rubber clone trials

RAS 1.2a and b - West Kalimantan - RAS1.2 Jambi

The trials confirmed the excellent growth performances of PB 260 and RRIC 100 rubber clones. Other clones BPM 1 and RRIM 600 obtained a significantly slower growth than PB260, used as control. BPM 1 clone suffered a physiological leaf fall (wintering) which affected growth in 1999.



PB 260 confirmed an excellent girth increment: 9 cm/year in Kalimantan and 11 cm/year in Jambi. This results strongly confirm the suitability of PB 260 and RRIC 100 in rubber agroforestry development.



In Jambi and Kalimantan. plants from polyclonal seeds and seedlings have a slower growth than clonal plants.

Rubber planting material recommended in RAS

PB 260 and RRIC 100 obtained the best growth in RAS 1 environment. These clones are leaf diseases tolerant and can be recommended for wide use by smallholders.

3. Fertilizer trial

RAS1.3 Jambi

No significant differences were found between fertilized and unfertilized plots; this result indicates the relative fertility of piedmont soils in Jambi. Jambi finding can not be generalized to other situations because rubber experiments in other provinces and the fertilizer trials in West Sumatra have indicated the need for fertilization in the young age.

Standard fertilizer recommendations for rubber are:

Planting time: Rock phosphate RP 500g in planting hole
Year 1: Urea 50g/tree every 3 months
Year 2: Urea 50 g/tree every 3 months
In Year 3, Urea may be needed if grasses are not well controlled.

In some conditions, additional applications of phosphorus (SP36) or KCl could be needed.

RAS 2 Trials

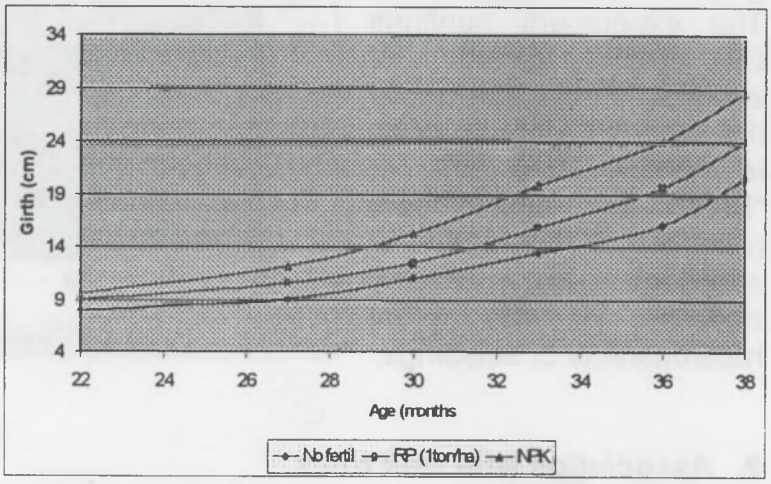
These trials associate annual and perennial crops to generate additional income and to reduce weeding requirement on rubber.

1. RAS2.2 trials in critical land (West Sumatra).

RAS trials were established in critical land: eroded soils, low fertility, *Imperata* grassland, on slope and at 600 to 700 meters above sea level, marginal elevation for rubber cultivation. Minang farmers successfully overcame those constraints by a continuous cultivation of annual crops and the planting of contour hedges of *Flemingia macrophylla*. As the result rubber grew well with an average girth increment of 8 cm/year confirming the suitability of rubber for re-greening activities in critical lands.

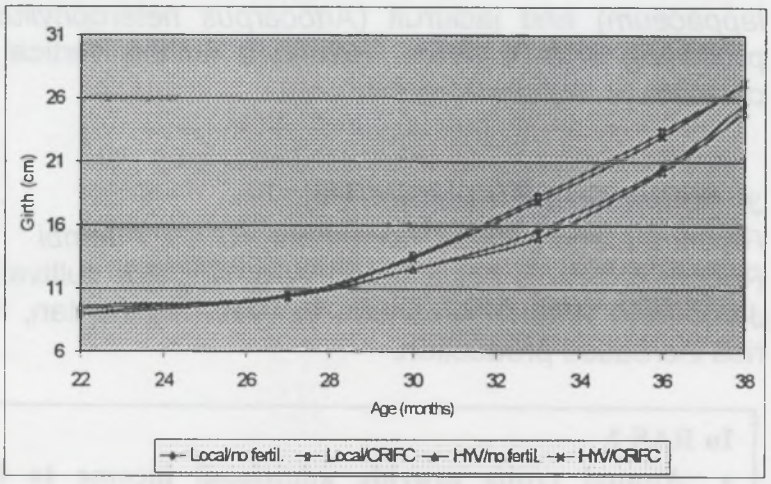
Fertilization trial RAS2.2a West Sumatra

Rock phosphate application or a complete fertilization NPK significantly improves rubber girth by 16% and 39% respectively. In such critical soils, Phosphate and Nitrogen fertilizers are clearly needed. These results confirm the 1995 observations made by the Potash and Phosphor Institute (PPI), which showed that annual crops like rice or peanut yield better after phosphate applications.



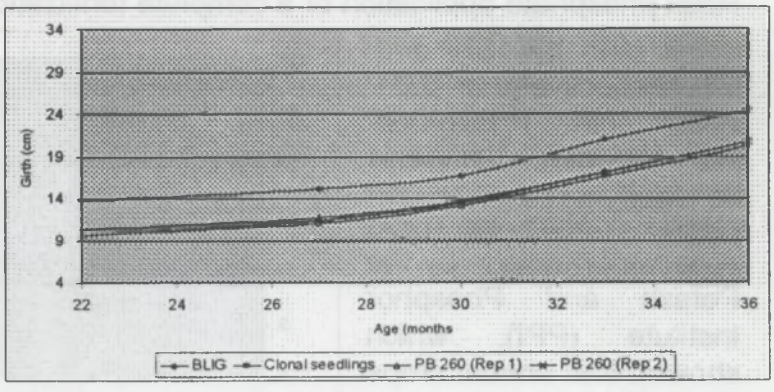
Annual crops trial 2.2 b

Annual crops (upland rice) cultivated with fertilizers significantly improved rubber girth by 9%. The trial shows a residual effect of fertilizers in these critical soils and it confirms the need to correct the severe P and N deficiencies. Rubber benefits from fertilization applied on annual crops.



Plant material test 2.2c

PB 260 clone has a slower growth than polyclonal seedlings known as "BLIG". Polyclonal plants were well developed at planting time and they maintained a growth advantage after. The experiment confirms the rapid growth of seedling plants, especially if a strict selection is done in nursery. The use of "BLIG" by smallholders requires a severe culling of seedlings in nursery because of the great heterogeneity of seedlings.



2. Association with fruit trees

RAS 2.1a and b West Kalimantan - RAS 2.5 Jambi

The fruit trees planted between rubber rows didn't affect rubber growth. The associations are often beneficial to rubber because of intensive weeding done in the plots. Weeds and grasses are also controlled by the shading effect of associated trees. Durian (*Durio zibethinus*) is the favorite choice of farmer but this tree has a very slow growth in early stages. Rambutan (*Nephelium lappaceum*) and jackfruit (*Artocarpus heterophyllus*) are the only fruit trees producing after 4 years. Having a limited vertical growth, these trees don't compete for light with rubber.

3. Annual crops (upland rice)

RAS 2.2 a and b West Kalimantan, RAS 2.2 Jambi

Rubber growth is not affected by upland rice cultivation either fertilized or not in Jambi and West Kalimantan. In West Kalimantan, fertilizers applied on upland rice increased production.

In RAS 2

- **Annual crops provide additional income to farmers and provide good maintenance standard for rubber.**
- **Residual fertilizers applied on annual crops are partly utilized by rubber, achieving better efficiency of inputs.**
- **Fruit trees found suitable in trials are: rambutan and jackfruit trees. Unselected durians grow very slowly; grafted durians are recommended for obtaining early harvest.**

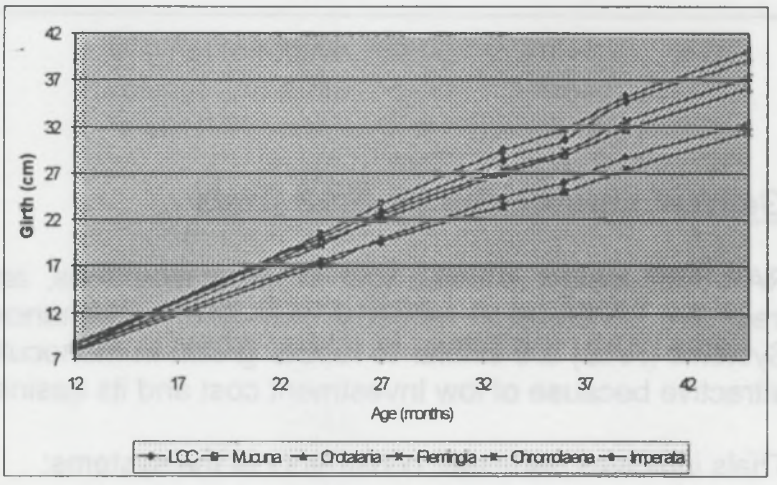
RAS 3 trials

RAS 3 are established in *Imperata* grasslands, which requires high development costs. A complete eradication of *Imperata* requires a lot of inputs i.e. spraying equipment, herbicide, legume cover seeds, fertilizers and labor days. The RAS 3 strategy aims to reduce development cost in grasslands and to ensure a good success rate in this difficult environment.

1. Cover crop experiments

RAS 3.2 a and b

Pueraria javanica is effective in controlling *Imperata*. Other cover plants like *Crotalaria mucronata* and *Flemingia macrophylla* achieved only a partial control of *Imperata*. *Mucuna pruriens* is not effective in controlling *Imperata* due to its short life span and it needs to be re-planted every year. *Mucuna* should be associated with *Pueraria* because it helps the establishment of the later. In pure *Imperata* and *Chromolaena odorata* plots, rubber growth is significantly affected by -18% if compared to *Pueraria* plots. Rubber growth performances are variable between plots because of the highly variable composition of weeds in the plots and its evolution. For instance, many *Chromolaena* plots have a wide coverage of *Imperata* and the poor rubber growth observed in the plots is mainly due to *Imperata* extent. *Gliricidia sepium* helps also the control of *Imperata* but it requires frequent prunings to prevent competition for light with rubber.



2. Fast Growing Trees (FGT)

RAS 3.3 and 3.4 West Kalimantan

Fast growing trees (FGT) are effective to control the *Imperata* by shading. *Acacia mangium* has the fastest growth in the first 3 years. Other species: *Gmelina arborea*, *Paraseriantes falcataria* (Albizia) obtained variable results due to modest growth or a canopy development inferior to *Acacia mangium*.

The spacing for *Acacia mangium* in the interrow should be reconsidered. *Acacia mangium* is successful in controlling Imperata but due its vertical development, it competes for light with rubber and consequently, it must be felled after 4 years. At this age *Acacia* can't be used for pulp but only for firewood. Wider spacing between rubber row must be considered and tested for pulp wood production.

How to convert imperata grassland

- Fast growing trees are effective to control *imperata* but as they must be pruned during the 4 year they can not be sold as pulpwood.
- Gmelina arborea and *Paraseriantes falcataria* branched easily after regular pruning and can be shaped to control imperata faster.
- Multiplication/dissemination of the 2 species is easy by cuttings

General conclusion on RAS trials

RAS trials clearly showed that in many situations, annual crops or associated trees are beneficial to rubber growth and performances in Rubber Agroforestry Systems (RAS) are similar to rubber grown in monoculture. RAS 1 has particular attractive because of low investment cost and its easiness for implementation.

Trials indicates particular constraints of the systems:

1. Quality of planting material

Trials showed the limitations of the systems and the importance of the quality of planting material: **well-developed plants with root stock at least 12 months old**. Data below indicated the influence of planting condition on rubber growth performances.

Plantation	Weeding frequency	Age (months)	Girth (cm)	Annual girth increment (cm/year)
Feb 95 (Small plants)	Low	54	25.3	5.6
Nov 96 (Well-developed plants)	Low	36	22.4	7.5

2. Clonal rubber under agroforestry condition

Under agroforestry environment, high yielding rubber clones have a sustained growth better than unselected seedlings. Initial growth during the 6 first months is critical to ensure good performances.

Average girth increment in different trials is presented below.

Type of trial	Jambi		West Sumatra		West Kalimantan	
	Girth (cm) (age in months)	Annual Girth Increment (cm/year)	Girth (cm) (age in months)	Annual Girth Increment (cm/year)	Girth (cm) (age in months)	Annual girth increment (cm/year)
RAS 1	41.6 (51)	9.8	-	-	34.8 (45)	9.3
RAS 2	43.9 (57)	9.2	39.4 (57)	8.3	37.5 (54)	8.3
RAS 3.2	-	-	-	-	36.1 (45)	9.6
RAS 3.4	-	-	-	-	34.8 (54)	7.7

An annual girth increment of 9 cm is considered as a standard growth for monoculture rubber plantations. This growth level is obtained in Jambi where soil conditions are favorable. In critical lands as in West Sumatra, rubber performances are satisfactory, taking into account the severe limitations.

In West Kalimantan annual growth of 8 to 9 cm is satisfactory taking into account poor soil fertility. In RAS 3, the best rubber growth was obtained with legume cover crops (RAS3.2). In other trials with associated trees (timber and fast growing trees), rubber was affected by *Imperata* in the early stages, before associated trees could control the weed by shading.

3. Weeding requirement

Weeding frequency* studied in RAS 1 trials, showed than a low weeding frequency doesn't significantly affect rubber growth. Quality of weeding is an important factor (slashing or hoeing) and a good weeding performed near the rubber trees is needed to prevent adverse weed competition. In West Kalimantan chemical weeding (glyphosate) was used to control *Imperata* and grasses.

4. Role of natural vegetation re-growth and associated trees

Trials showed the effectiveness of natural vegetation and fast growing trees (FGT) to control weeds but weeding is still needed on the rubber row. To reduce weeding requirements various associations of plants on the planting row should be tested in order to improve rubber growth and to limit weeding requirements. Possible associations on rubber row are: cover crops (*Flemingia* or LCC), *Gliricidia*, corn or banana. These associations would be temporary and eliminated when tapping starts.

5. Pests and diseases

In Jambi, wild pigs and dears cause severe damages to rubber. Farm fencing and individual tree protection improve rubber survival and limit pest incidence. In West Kalimantan white root disease appeared in Year 3 and caused some damages. Its incidence is more frequent in RAS 1 than in RAS 3.

Pink disease caused by *Corticium salmonicolor* is present in West Kalimantan but extent of the disease is limited. Rubber clones used in RAS trials (PB260, RRIC 1000, RIM 600, and BPM 1) are not affected by leaf diseases prevalent in the province like *Colletotricum* or *Corynospora.* Tested clones were found suitable for further dissemination in the province.

Insects like termites and borers *Xyleborus sp.* can cause some damages and regular pest control must be conducted.

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RAS TRIALS IN WEST SUMATRA

GAS TRAPS IN WEST SUMATRA

WEST SUMATRA - RAS 2.2a /Rubber fertilization

TITLE: Clonal rubber in agroforestry environment : rubber + selected associated trees + intercropping / ***Treatment on rubber fertilization***

OBJECTIVE/HYPOTHESE
Objectives

As in jungle rubber system where rubber seedlings are associated with various kind of trees and plants, RAS 2.2 aims to associate useful trees (fruits and timber trees) with rubber, at a limited planting density, without substantial decrease in rubber yield.
Rubber is planted at normal planting density of 550/ha as associated trees are planted at 92 trees/ha with a maximum number of 30 for big trees. In that case, fertilization of rubber may be a key factor in the trade-off between fertilization and level of weeding. In the case of East Pasaman area where fields are continuously cropped, weeding is not anymore a key factor as rubber trees are well weeded. The critical situation of the land : slope with high risk of erosion , poor soils , erratic rainfall and local severe drought during dry season as well as altitude implies that rubber should grow very fast during early stage after planting.
This trial is aimed to compare 3 level of fertilization on clonal rubber in RAS 2.2 system.

Hypotheses :

General hypotheses for RAS 2.2:
- It is expected that rubber growth during immature period will not be affected by associated trees competition as these selected fruits and timber trees have generally a slow growth pattern (in particular for durian, local fruits and timber species).
- It is expected that intercropping during the first 3 or 4 years of rubber immature period will create a favorable environment for a good rubber growth due to intercrop weedings and secondary effect of fertilization.
- Intercropping will limit the extend of weeds such as Imperata.
- Specifically for RAS 2.2A in West-Sumatra :
- We do not know in the specific conditions of West-Sumatra if rubber need fertilization or not, and at which level.

EXPECTED OUTPUTS

To produce recommendations on components of RAS 2.2:
- rubber fertilization management required for successful growth of rubber clone in this environment

LOCATION : West Sumatra, East Pasaman, village of Bangkok

YEAR :
planting of rubber :
first planting : January 1996
Replanting : October 1996 :

DURATION
5 to 6 years for immature period. The first 2 years are critical in terms of growth and survivability. Then, if possible, a minimum of 3 years of production monitoring.

MATERIALS AND METHOD
Rubber + intercropping + associated trees : **on all plots.**

Treatments on rubber fertilization

PLOT A : **"0 fertilization,**

PLOT B : **" application of high amount of Rock Phosphate (RP) at planting time only** (1 ton /ha or RP, 27.5 % in the planting hole and 72.5 % broadcast in the field at planting time), so:
- in the planting hole : 500 grams per trees (275 kg/ha)
- broadcast in the field at planting time : 725 kg/ha

PLOT C : **complete TCSDP fertilization program** for the first 2 years with RP at planting time and NPK fertilization every 3 months).

The difference with RAS 1.3 in Jambi is that it is basically a RAS 2 (and not a RAS 1 like in Jambi) and that there are only 3 treatments (and not 4 like in Jambi)

TCSDP fertilization program is the following:

In g/tree

	Planting time October 96	+ 3 months January 97	+ 6 months April	+ 9 months July	+ 12 months October
RP	200				
Urea		50	50	50	50
SP36		40	40	40	40
KCl			40	40	40

TCSDP fertilization is supplied for the first 2 years only up to October 1998.

EXPERIMENTAL DESIGN
Randomized block system
2 replications per farm.
2 farms
Total number of replication: 4
RUBBER
All replications are planted with RRIC 100.

FERTILIZATION

PLOT A : O fertilization.
PLOT B : RP only at planting time
PLOT C : TCSDP fertilization program only for the first 2 years. No fertilization later.

Rubber planting distance
Standard : 550 trees/ha : 3 x 6 meters.

Rubber weeding :

6 weeding a year, every 2 months, on a regular basis. Local observation and presence of alang[2] may change that pattern.

INTERCROPPING

Rice is not a treament is this trial. The same variety with the same amount for fertilization is cropped in all the field.
Local rice has been planted in 1995/96 without fertilization.
Local rice has been planted in 1996/97 without fertilization.
FOR 1997 :
Rainy season
Local rice hs been planted in July/August 1997, no fertilization
Weeding : 2 weeding during growth.

Rice has failed.
for 1998 : to be decided : if possible : improved rice (Jatiluhur with BPS fertilization dose).

"BPS fertilization dose" is the economic dose recommended by BPS/Sembawa for JAMBI.

FERTILIZATION DOSE

Dose in Kg/ha	Urea	SP 36	KCl
BPS	100	160	75

Urea is supplied in 3 times : 1/3 at planting time, 1/3 1 month after planting and 1/3 2 months after planting.

Dry season

According to farmers strategy: nothing or palawijas or rice : such as groundnut which is the best inter crop for dry season. No fertilization.

ASSOCIATED TREES

Planting density : 92 trees/ha : 9 x 12 meters.
Selected trees are durian, Petai, Jengkol, Kemiri and Cinnamon + other trees according to local situation.
The associated trees frame should be the same for all trials, or similar.
Weeding : same as for rubber (6 weeding/year).

FIELD SIZE per farm

PLOT SIZE : 1000 m²
NUMBER OF PLOTS PER REPLICATION : 3 plots
NUMBER OF REPLICATION/farm : 2
NUMBER of FAMS : 2
REPLICATION/FARM SIZE : 6 plots : 6 000 m²

TOTAL SIZE OF THE TRIAL : 1.2 ha with 2 farmers
Total number of replication : 4

DATA TO BE COLLECTED

Standard data for all RAS 2.2:

RUBBER

- rubber growth measurements : diameter, height and whorls the first year every 3 months. Then girth the second year every 3 months. Sample of 30 trees per plot (according to field maps).
- Farmer's labour for each plot.
- soil samples per replication on 0-15 and 15-30 cm.

Total number of soil samples for the 2 farms : 6 plots x 2 rep x 2 soil depths = 24

ASSOCIATED TREES

- tree growth measurements : girth every year at planting anniversary time for all trees per plot.

RICE

- date of planting
- date of harvest
- yield of each plot with a sample of 100 grams to be sent to ICRAF/Bogor for water content measurement.

Labor requirement per plot, recorded by farmers and controlled by PPL.

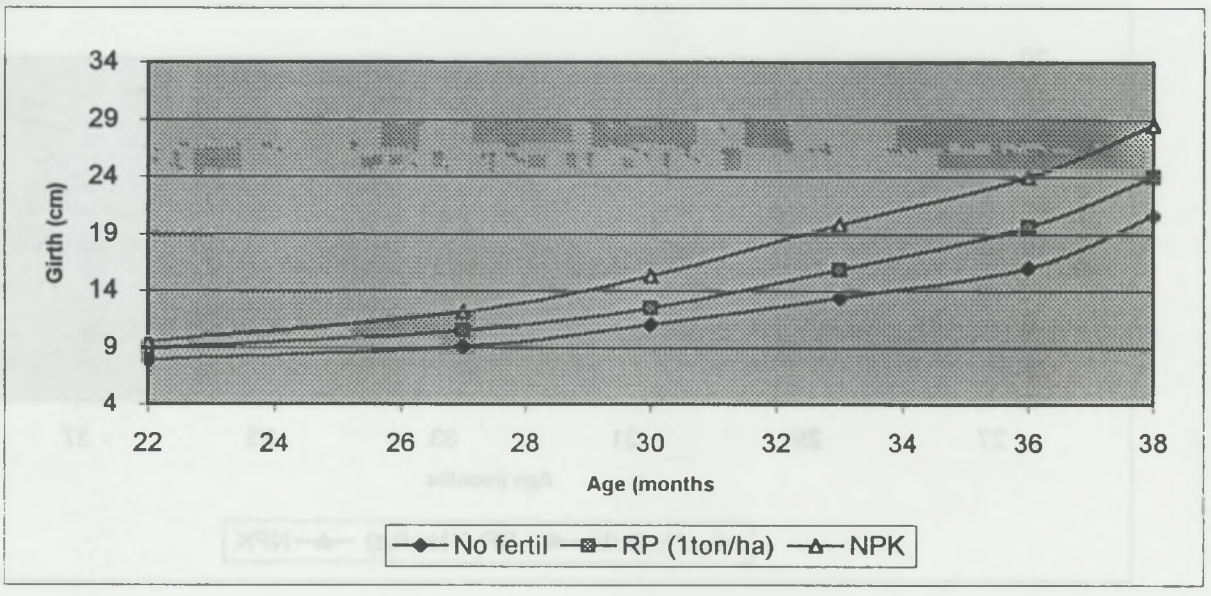
RAS 22a - WEST SUMATRA
Effect of fertilization on rubber girth

Planting date: January 1996 - supplies in Oct 1996 - Bangkok

Farmer		Fertilizer level	Girth (cm)						
			Nov-97	Apr-98	Jul-98	Oct-98	Jan-99	Mar-99	Oct 99*
Ema 1 (replic 1)	A	No fertil	7.0	8.2	10.1	12.4	14.8	20.0	33.9
	B	RP (1ton/ha)	8.0	10.1	12.0	15.0	18.4	21.8	36.2
	C	NPK	8.3	11.8	15.0	19.6	23.8	27.9	40.4
Ema 2 (replic 1)	A	No fertil	7.8	8.9	10.8	12.9	15.2	20.2	40.9
	B	RP (1ton/ha)	8.7	10.2	12.2	15.1	18.4	22.2	40.6
	C	NPK	9.8	12.1	15.1	19.4	23.5	28.4	41.5
Warni 1 (replic 1)	A	No fertil	8.8	10.0	11.9	14.3	17.4	20.7	38.8
	B	RP (1ton/ha)	9.5	10.9	12.8	17.1	21.1	26.4	36.5
	C	NPK	9.1	11.4	14.6	19.3	23.6	28.8	39.7
Warni 2 (replic 1)	A	No fertil	8.1	9.3	11.3	14.0	16.7	21.5	42.8
	B	RP (1ton/ha)	9.5	10.9	13.0	16.3	20.8	25.5	38.6
	C	NPK	10.9	13.3	16.5	21.0	25.0	29.1	32.9
Average	**A**	**No fertil**	**7.9**	**9.1**	**11.0**	**13.4**	**16.0**	**20.6**	**39.1**
	B	**RP (1ton/ha)**	**8.9**	**10.5**	**12.5**	**15.9**	**19.7**	**24.0**	**38.0**
	C	**NPK**	**9.5**	**12.1**	**15.3**	**19.8**	**24.0**	**28.6**	**38.6**

* : different tree sample

Effect of fertilization on rubber growth

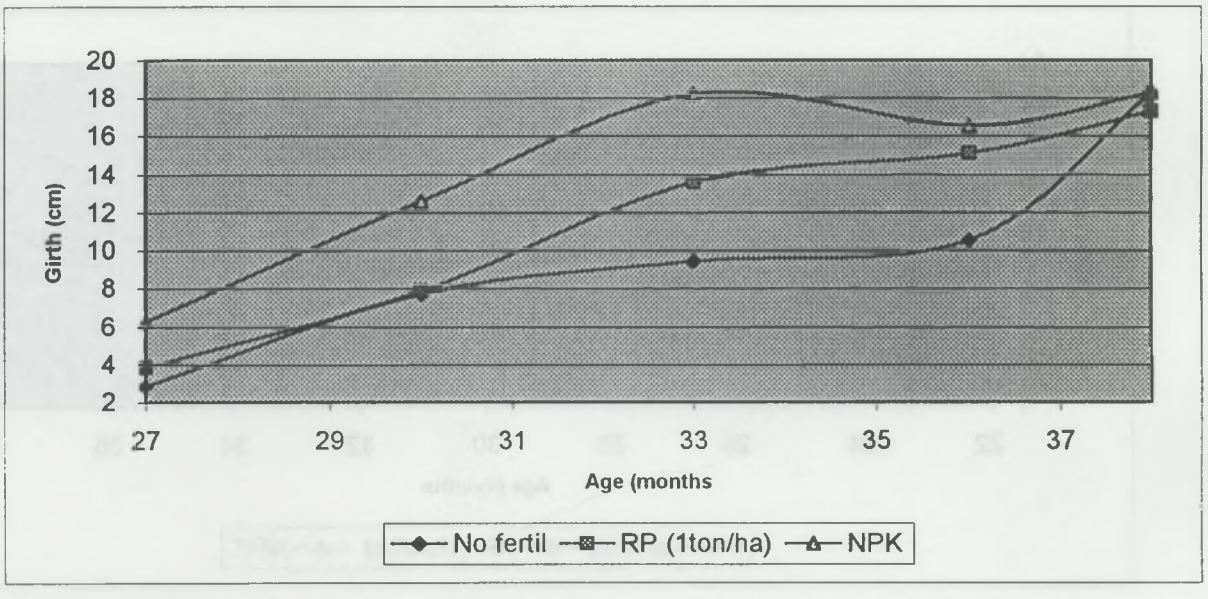


RAS 22a - WEST SUMATRA
Effect of fertilization
on annual girth increment of rubber

Planting date: January 1996 - supplies in Oct 1996 - Bangkok

Farmer		Fertilizer level	Girth (cm)						
			Nov-97	Apr-98	Jul-98	Oct-98	Jan-99	Mar-99	Oct 00
Ema 1	A	No fertil		2.9	7.7	9.2	9.5	20.7	9.8
(replic 1)	B	RP (1ton/ha)		5.1	7.7	12.1	13.5	13.7	10.2
	C	NPK		8.3	12.9	18.3	16.7	16.5	8.8
Ema 2	A	No fertil		2.8	7.3	8.7	9.2	19.8	14.6
(replic 1)	B	RP (1ton/ha)		3.6	7.9	11.7	13.2	15.2	13.0
	C	NPK		5.6	11.9	17.5	16.3	19.5	9.2
Warni 1	A	No fertil		2.8	7.8	9.3	12.6	13.2	12.8
(replic 1)	B	RP (1ton/ha)		3.3	7.8	17.2	15.9	21.3	7.1
	C	NPK		5.5	12.8	18.8	17.2	20.7	7.7
Warni 2	A	No fertil		2.9	8.0	10.6	10.8	19.3	15.0
(replic 1)	B	RP (1ton/ha)		3.4	8.2	13.3	17.9	19.0	9.3
	C	NPK		5.7	12.9	18.1	16.0	16.4	2.7
Average	**A**	**No fertil**		**2.8**	**7.7**	**9.4**	**10.5**	**18.3**	**13.1**
	B	**RP (1ton/ha)**		**3.8**	**7.9**	**13.6**	**15.1**	**17.3**	**9.9**
	C	**NPK**		**6.3**	**12.6**	**18.2**	**16.6**	**18.3**	**7.1**

Effect of fertilization on annual girth increment



RAS 22a - WEST SUMATRA

Girth at 38 months (cm)

Farmer	No fertil	RP (1ton/ha)	NPK
Ema 1	20.0	21.8	27.9
Ema 2	20.2	22.2	28.4
Warni 1	20.7	26.4	28.8
Warni 2	21.5	25.5	29.1

Anova: Two-Factor

SUMMARY	*Count*	*Sum*	*Average*	*Variance*		
Ema 1	3	69.70	23.23	17.14		
Ema 2	3	70.80	23.60	18.28		
Warni 1	3	75.90	25.30	17.31		
Warni 2	3	76.10	25.37	14.45		
No fertil	4	82.40	20.60	0.45	lsd 5% =	1.87
RP (1ton/ha)	4	95.90	23.98	5.36	lsd 1% =	2.83
NPK	4	114.20	28.55	0.27		

ANOVA

Source of Variati	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*	
Farmer	11.229	3	3.74	3.20	0.10	4.76	
Fertilizer	127.365	2	63.68	54.52	0.00	5.14	**
Error	7.008	6	1.17				
Total	145.603	11					

No fertil	20.60	a
RP (1ton/ha	23.98	b
NPK	28.55	c

a,b,c: Classification groups according to Duncan's test at 5% significance threshold

WEST SUMATRA - RAS 2.2a

1. Trial implementation

The trial studies different fertilization schemes for rubber. West Sumatra soils are marginal for rubber development therefore, fertilization can play an important role in sustainable rubber growth.
As rubber is planted in former *Imperata* grasslands, fertilization can help an early growth of rubber and normal development.

2. General observations on trial

Rubber growth was very satisfactory considering the particular conditions of West Sumatra lands (marginal land). Previous observations by Potash and Phosphor Institute (PPI) indicated the low phosphor content in the soils. Rubber developed very slowly during the first year then, it obtained a normal growth. The average girth increment of 7.7 cm/year is inferior to the standard growth of 9 cm/year but, this performance is satisfactory for marginal soils with many limitations as: soil fertility, slope, elevation above sea level, and noxious weed pressure.

3. Treatment analysis

The trial compares two fertilizer schemes and a control without fertilizer.
Treatments (4 replications):

Treatment fertilization scheme	Girth in cm (%)
Control (no fertilizer)	20.6 (100)
Rock Phosphate (1 ton/ha)	24.0 (117)
NPK	28.6 (139)

Statistic analysis indicates that Rock Phosphate application and a complete fertilization (NPK) increase significantly rubber growth. Girth increment is particularly impressive +39%! with a complete fertilization, indicating the poor fertility of West Sumatra soils. A new tree sample was made in October 2000 and there are no significant difference between treatments

4. Conclusion

Rubber clones perform well in critical soils of West Sumatra. A complete fertilization with Nitrogen and Phosphor is needed to obtain a satisfactory rubber growth. Rubber growth was particularly slow during the first year, indicating that a regular fertilization and weeding are necessary during early stages but after a sustained growth can be obtained

RAS 2.2b/ RICE TRIAL: VARIETY & FERTILIZATION
Rubber + associated trees + intercropping

TITLE :
Clonal rubber in agroforestry environment: rubber + selected associated trees + intercropping / ***treatment on rice varieties and amount of fertilization***.

OBJECTIVE/HYPOTHESE
Objectives

As in jungle rubber system where rubber seedlings are associated with various kind of trees and plants, RAS 2.2 aims to associate useful trees (fruits and timber trees) with rubber, at a limited planting density, without substantial decrease in rubber yield.
Rubber is planted at normal planting density of 550/ha as associated trees are planted at 92 trees/ha with a maximum number of 30 for big trees.
Rice intercropping provides to rubber a indirect good weeding management and good conditions for growth.
The objective is to optimize in farmers conditions rice cropping with the best adapted technological package acceptable by local farmers

Hypotheses

General hypothesis for RAS 2.2:
- It is expected that rubber growth during immature period will not be affected by associated trees competition as these selected fruits and timber trees have generally a slow growth pattern (in particular for durian, local fruits and timber species).
- It is expected that intercropping during the first 3 or 4 years of rubber immature period will create a favorable environment for a good rubber growth due to intercrop weeding and secondary effect of fertilization..
- Intercropping will limit the extend of weeds such as Imperata.
- there is an indirect benefit of rice fertilization on rubber.

Specific for RAS 2.2 b:
We do not know in the specific conditions of West-Sumatra what are the best-adapted rice varieties and their management (weeding and fertilization) as well as the best adapted crop rotation.

EXPECTED OUTPUTS

To produce recommendations on components of RAS 2.2:
Rice varieties, fertilization level and rotation (with palawijas).

LOCATION : WEST SUMATRA , East Pasaman, village of Bangkok

YEAR :
planting of rubber : January 1996
Replanting : October 96

DURATION
5 to 6 years for immature period. The first 2 years are critical in terms of growth and survivability. Then, if possible, a minimum of 3 years of production monitoring.

MATERIALS AND METHOD
Rubber + intercropping + associated trees on all plots.

Treatments:
A (rice varieties) **x B** (fertilization level):

Treatment A: Local rice or improved rice : + 0 fertilization.

Treament B: Local rice or improved rice + recommended CRIFC fertilization program.

Treatment C: Improved rice (Way rarem/Jatiluhur) + 0 fertilization

Treatment D: Improved rice (Way rarem/Jatiluhur) + recommended CRIFC fertilization program.

Urea is provided in 3 periods: planting time, + 40 days and + 80 days after planting. Chemical treatment against pests and diseases.
Weeding : 2 weeding during growth.

CRIFC fertilization dose is the dose recommended by CRIFC/Bogor for JAMBI.

FERTILIZATION DOSE

Dose in Kg/ha	Urea	SP 36	KCl
CRIFC	150	220	150

EXPERIMENTAL DESIGN
Randomized block system with 2 treatments: variety x fertilization

1 replication per farm. 4 plots per farm, 4 farms
Total number of replications, 4 rep.
All replications are planted with PB 260

RUBBER FERTILIZATION
TCSDP fertilization program only for the first 2 years. No fertilization later.
TCSDP fertilization program is the following:

In g/tree

	Planting time October 96	+ 3 months January 97	+ 6 months April	+ 9 months July	+ 12 months October
RP	200				
Urea		50	50	50	50
SP36		40	40	40	40
KCl			40	40	40

The amount of each fertilizer to be supplied to the plots is calculated in annex for each farmer and for each plot.

RUBBER PLANTING DISTANCE
Standard : 550 trees/ha : 3 x 6 meters.

RUBBER WEEDING :
6 weeding a year , every 2 months, on a regular basis. Local observation and presence of alang may change that pattern.

INTERCROPPING

Rainy season
See treatments on rice

Dry season
According to farmers strategy: nothing or palawijas: such as groundnut which is the best intercrop for dry season.

ASSOCIATED TREES

Planting density : 92 trees/ha : 9 x 12 meters.
Selected trees are durian, Petai, Jengkol, Kemiri and Cinnamon + other trees according to local situation.
The associated trees frame should be the same for all trials, or similar.
Weeding : same as for rubber (6 weeding/year).

FIELD SIZE per farm
PLOT SIZE : 1000 m
NUMBER OF PLOTS PER REPLICATION : 4 plots
NUMBER OF REPLICATION/farm : 1
REPLICATION/FARM SIZE: 4 plots : 4 000 m
Number of farms : 4
TOTAL SIZE OF THE TRIAL : 1.6 ha with 4 farmers
Total number of replication: 4

DATA TO BE COLLECTED

Standard data for all RAS 2.2 :

RUBBER
- rubber growth measurements : diameter, height and whorls the first year every 3 months. Then girth the second year every 3 months. Sample of 30 trees per plot.
- Farmer's labor for each plot.
- soil samples per replication on 0-15 and 15-30 cm.

Total number of soil samples for the 2 farms:
4 plots x 2 rep x 2 soil depths = 16 (Badul and Muktar)
2 fields x2 soild depth = 4 (Siam and Burham)
Total = 20

ASSOCIATED TREES
tree growth measurements : girth every year at planting anniversary time for all trees per plot.

RICE
- date of planting
- date of harvest
- yield of each plot with a rice sample of 100 grams to be sent to Bogor to control the water content
- Labor requirement per plot.

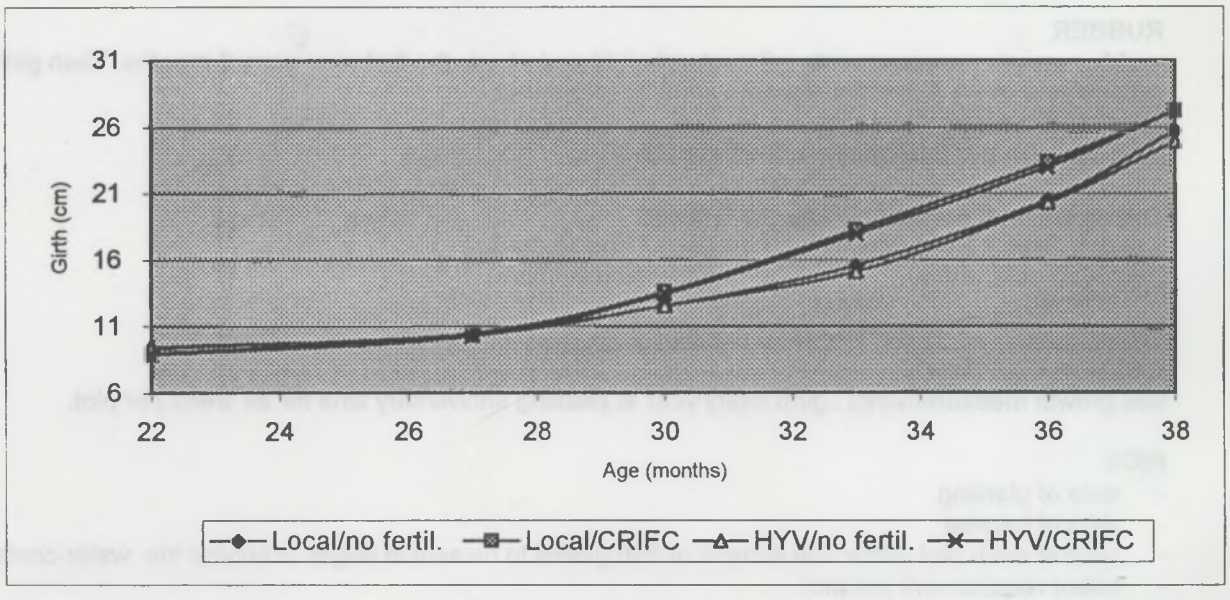
RAS 22b - WEST SUMATRA
Effect of rice cultivation on rubber girth

Planting date: January 1996 - supplies in Oct 1996 - Bangkok

Farmer		Rice var/ Fertilizer	Girth (cm)						
			Nov-97	Apr-98	Jul-98	Oct-98	Jan-99	Mar-99	Oct 99*
Siam	A	Local/no fertil.	10.3	11.6	13.6	16.6	21.0	26.0	40.8
	B	Local/CRIFC	10.7	13.0	15.9	19.6	24.9	29.2	40.9
	C	HYV/no fertil.	12.2	12.7	14.8	17.3	22.6	27.4	43.5
	D	HYV/CRIFC	10.6	12.2	15.1	19.0	24.3	29.4	40.2
Burhan	A	Local/no fertil.	9.7	10.6	12.6	15.7	21.1	26.2	40.0
	B	Local/CRIFC	9.4	11.1	14.2	18.7	24.0	28.7	39.8
	C	HYV/no fertil.	10.4	11.1	13.2	16.2	21.6	25.9	39.8
	D	HYV/CRIFC	9.4	11.2	14.3	19.4	24.7	28.4	42.0
Muktar	A	Local/no fertil.	8.6	9.6	11.8	14.9	20.4	25.5	36.3
	B	Local/CRIFC	7.8	8.8	12.0	17.2	22.5	25.8	29.9
	C	HYV/no fertil.	7.5	8.5	10.7	12.8	18.1	22.8	36.2
	D	HYV/CRIFC	7.6	8.6	11.8	16.7	21.9	26.9	33.9
Badul	A	Local/no fertil.	8.8	9.9	12.1	15.0	19.7	25.0	43.4
	B	Local/CRIFC	8.0	9.1	12.2	17.6	22.2	25.1	43.3
	C	HYV/no fertil.	7.9	9.0	11.2	13.9	18.9	23.6	42.4
	D	HYV/CRIFC	7.8	9.0	12.3	16.5	21.1	24.3	37.3
Average	**A**	**Local/no fertil.**	**9.3**	**10.4**	**12.5**	**15.6**	**20.5**	**25.7**	**40.1**
	B	**Local/CRIFC**	**9.0**	**10.5**	**13.6**	**18.3**	**23.4**	**27.2**	**38.5**
	C	**HYV/no fertil.**	**9.5**	**10.4**	**12.5**	**15.1**	**20.3**	**24.9**	**40.5**
	D	**HYV/CRIFC**	**8.8**	**10.3**	**13.4**	**17.9**	**23.0**	**27.3**	**38.3**

*: New tree sample

Effect of rice cultivation on rubber growth



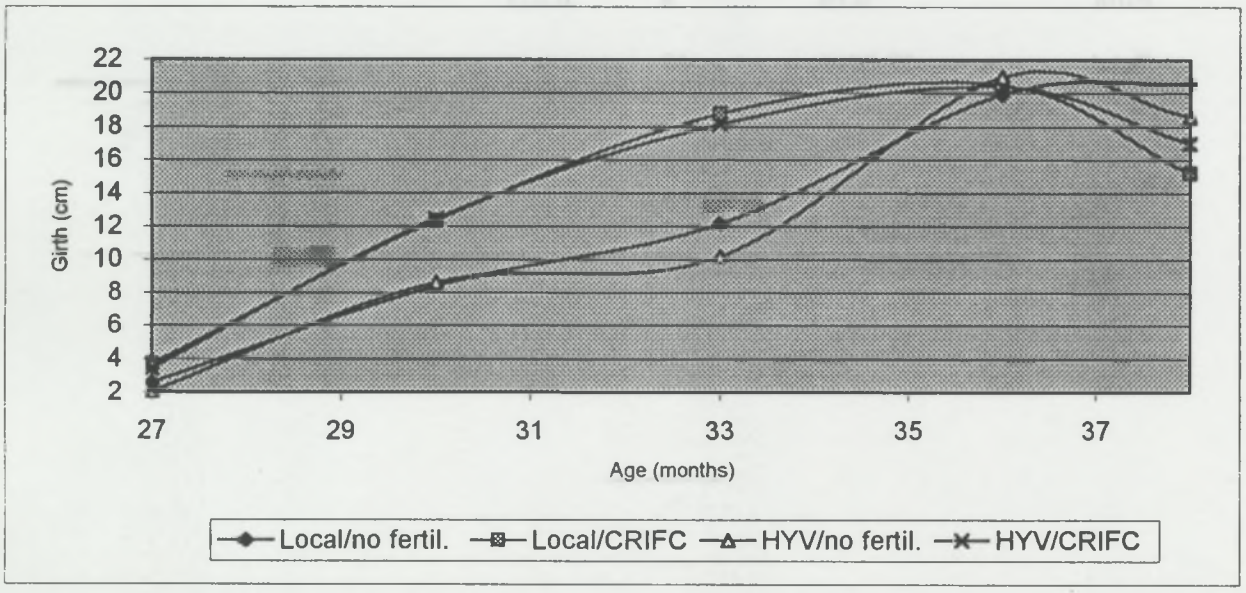
RAS 22b - WEST SUMATRA
Effect of rice cultivation on annual girth increment of rubber

Planting date: January 1996 - supplies in Oct 1996 - Bangkok

Farmer		Rice var/ Fertilizer	Annual girth increment (cm)					
			Nov-97	Apr-98	Jul-98	Oct-98	Jan-99	Mar-99	Oct 99*
Siam	A	Local/no fertil.		3.1	7.8	12.2	17.4	20.1	10.5
	B	Local/CRIFC		5.4	11.9	14.8	21.1	17.1	8.2
	C	HYV/no fertil.		1.2	8.4	9.9	21.2	19.2	11.3
	D	HYV/CRIFC		3.9	11.7	15.4	21.1	20.6	7.6
Burhan	A	Local/no fertil.		2.1	8.2	12.3	21.5	20.5	9.8
	B	Local/CRIFC		4.1	12.5	18.1	21.3	18.7	7.8
	C	HYV/no fertil.		1.9	8.3	11.9	21.5	17.3	9.8
	D	HYV/CRIFC		4.4	12.3	20.6	21.2	14.7	9.6
Muktar	A	Local/no fertil.		2.6	8.8	12.4	21.8	20.4	7.6
	B	Local/CRIFC		2.5	12.9	20.6	21.2	13.3	2.9
	C	HYV/no fertil.		2.4	8.6	8.4	21.3	18.8	9.5
	D	HYV/CRIFC		2.5	12.8	19.5	20.9	19.9	4.9
Badul	A	Local/no fertil.		2.6	8.7	11.7	18.9	21.2	13.0
	B	Local/CRIFC		2.7	12.2	21.5	18.4	11.8	12.8
	C	HYV/no fertil.		2.7	9.0	10.6	19.9	18.9	13.3
	D	HYV/CRIFC		2.9	13.1	17.0	18.2	12.8	9.2
Average	**A**	**Local/no fertil.**		**2.6**	**8.4**	**12.2**	**19.9**	**20.6**	**10.2**
	B	**Local/CRIFC**		**3.7**	**12.3**	**18.7**	**20.5**	**15.2**	**7.9**
	C	**HYV/no fertil.**		**2.1**	**8.6**	**10.2**	**21.0**	**18.6**	**11.0**
	D	**HYV/CRIFC**		**3.4**	**12.4**	**18.1**	**20.4**	**17.0**	**7.8**

*: New tree sample

Effect of rice cultivation on annual girth increment



RAS 22b - WEST SUMATRA

Rubber girth at 38 months (cm)

Farmer	Loc/ 0	Loc/CRIFC	HYV/0	HYV/CRIFC
Siam	26.0	29.2	27.4	29.4
Burhan	26.2	28.7	25.9	28.4
Muktar	25.5	25.8	22.8	26.9
Badul	25.0	25.1	23.6	24.3

Anova: Two-Factor Without Replication

SUMMARY	*Count*	*Sum*	*Average*	*Variance*	
Siam	4	112.03	28.01	2.57	
Burhan	4	109.20	27.30	2.11	
Muktar	4	101.00	25.25	3.03	
Badul	4	98.00	24.50	0.49	
Loc/ 0	4	102.70	25.68	0.29	
Loc/CRIFC	4	108.80	27.20	4.21	lsd 5% = 1.577
HYV/0	4	99.73	24.93	4.50	lsd 1% = 2.317
HYV/CRIFC	4	109.00	27.25	4.92	

ANOVA

urce of Variati	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*	
Farmer	33.02	3	11.005	11.327	0.002	3.863	**
Rice scheme	15.87	3	5.290	5.444	0.021	3.863	*
Error	8.74	9	0.972				
Total	57.6296	15					

HYV/0	24.93	a
Loc/ 0	25.68	a
Loc/CRIFC	27.20	b
HYV/CRIFC	27.25	b

a,b,c: Classification groups according to Duncan's test at 5% significance threshold

WEST SUMATRA RAS 2.2 b

1. Trial implementation

The trial studies upland rice (local and improved variety) cultivated with and without fertilizer at CRIFC recommendation doses. The purpose of the experiment is to determine a) if improved rice variety with proper inputs generates better income those local varieties and b) if rice cultivation affects rubber growth.

2. General observations on trial

Rubber growth is very satisfactory in particular in plot with fertilized rice. Rice production increases following applications of fertilizers but results are variable in relation with pest incidence.

3. Treatment analysis

The trial compares two types of upland rice (local and improved) and two levels of fertilization (0 and CRIFC recommendations)
Treatments:

Treatment: Planting Material	Girth in cm (%)
Local rice /No fertilizer	25.7 (100)
Local rice /CRIFC fertilizer dose	27.2 (106)
HYV rice /No fertilizer	24.9 (97)
HYV rice/CRIFC fertilizer dose	27.3 (106)
Effect of Fertilization on rice	
Rice/ no fertilizer	25.3 (100)
Rice/ CRIFC dose	27.3 (108)

Fertilizer application on rice has a significant effect on rubber growth. Fertilizers applied on rice in the inter-row improved the rubber girth by 8%. This result confirms the strong response of rubber to fertilizers in the poor soils of West Sumatra. In a new tree sample made in October 2000, there are no significant differences observed between treatments

4. Conclusion

Fertilization on rice improves rubber performance. This observation indicates that critical soils need fertilizers during the early stages to obtain a sustainable growth of rubber. The result is confirmed by the fertilizer response on rubber observed in RAS 2.2a trial.

RAS 2.2c/Rubber types (clones and seedlings)
Rubber + associated trees + intercropping

TITLE
Clonal rubber in agroforestry environment: rubber + selected associated trees + intercropping /
Comparison between rubber planting material: Clone vs. BLIG

OBJECTIVE/HYPOTHESE
Objectives

As in jungle rubber system where rubber seedlings are associated with various kind of trees and plants, RAS 2.2 aims to associate useful trees (fruits and timber trees) with rubber, at a limited planting density, without substantial decrease in rubber yield.
Rubber is planted at normal planting density of 550/ha as associated trees are planted at 92 trees/ha with a maximum number of 30 for big trees.
Various type of rubber planting material are available in particular clones and BLIG (polyclonal seedlings from North and South-Sumatra) : the aim is to do a comparison between rubber planting material : rubber clone vs BLIG (polyclonal seedlings from LONDON SUMATRA, North Sumatra). BLIG is a polyclonal seedling from the Bah Lias Isolated Garden.

Hypotheses

- Clonal rubber requires more weeding and maintenance those polyclonal seedlings.
- Use of polyclonal rubber seeds is less expensive that clones and easier to use (direct planting).
- The selected clones are resistant to leaf diseases, as BLIG seems to be very susceptible (as it has been observed in West-Pasaman).
- Clones productivity is higher that that of polyclonal seedlings.
- Polyclonal seedlings are very heterogeneous (30 % of the trees produce 70 % of the total production) leading to more labor and caution for tapping.
- growth of polyclonal seedlings is supposed to be more vigorous that that of clones, however this may be not true with fast growing early starter clones such as those selected for RAS (PB 260 and RRIC 100)

General hypotheses on RAS 2.2
- It is expected that rubber growth during immature period will not be affected by associated trees competition as these selected fruits and timber trees have generally a slow growth pattern (in particular for durian, local fruits and timber species).
- It is expected that intercropping during the first 3 or 4 years of rubber immature period will create a favorable environment for a good rubber growth due to intercrop weeding and secondary effect of fertilization..
- Intercropping will limit the extend of weeds such as Imperata.

EXPECTED OUTPUTS

To produce recommendations on components of RAS 2.2:
- rubber planting material suitability between BLIG and clones for East Pasaman conditions..

LOCATION : WEST SUMATRA , East Pasaman, village of Bangkok

YEAR : planting of rubber :
CLONE and BLIG: January 1996
- replanting : October 1996
Seedlings from South Sumatra: October 1996
These seedlings were sold by a South-Sumatra project as BLIG planting material but does not seem to be the same type as BLIG.

DURATION
5 to 6 years for immature period. The first 2 years are critical in terms of growth and survivability. Then, if possible, a minimum of 3 years of production monitoring.

MATERIALS AND METHOD
Rubber + intercropping + associated trees on all plots.

Treatments
PLOT A: Control: Clonal Rubber PB 260 (1 rep in one farm, Pak Udin) and RRIC 100 (1 rep in one farm : Pak Budiman)

PLOT B: BLIG from North-Sumatra

PLOT C: Seedlings from South-Sumatra

EXPERIMENTAL DESIGN
Randomized block system
1 replications per farm
2 farms: so 2 replications

RUBBER

FERTILIZATION

TCSDP fertilization program only for the first 2 years. No fertilization later.
TCSDP fertilization program is the following:

In g/tree

	Planting time October 96	+ 3 months January 97	+ 6 months April	+ 9 months July	+ 12 months October
RP	200				
Urea		50	50	50	50
SP36		40	40	40	40
KCl			40	40	40

RUBBER PLANTING DISTANCE
Standard : 550 trees/ha : 3 x 6 meters.

RUBBER WEEDING :

6 weeding a year , every 2 months, on a regular basis. Local observation and presence of alang² may change that pattern.

INTERCROPPING

Rainy season
Rice is no a treatment is this trial. The same variety at the same amount for fertilization is cropped in all the field.
Local rice has been planted in 1995/96 without fertilization.
Local rice has been planted in 1996/97 without fertilization.

FOR 1997 :

Rice will be planted in September 1997 : local rice + recommended Sembawa fertilization (100 kg urea + 130 kg SP 36 + 75 kg KCl). Urea is provided in 3 periods : planting time, + 40 days and + 80 days after planting.

Chemical treatment against pests and diseases.

Weeding : 2 weeding during growth.

"BPS fertilization dose" is the economic dose recommended by BPS/Sembawa for Jambi.

FERTILIZATION DOSE

Dose in kg/ha	Urea	SP 36	KCl
BPS	100	160	75

Urea is supplied in 3 times: 1/3 at planting time, 1/3 1 month after planting and 1/3 2 months after planting.

Dry season

According to farmers strategy: nothing or palawijas: such as groundnut which is the best inter crop for dry season.

ASSOCIATED TREES

Planting density : 92 trees/ha : 9 x 12 meters.

Selected trees are durian, Petai, Jengkol, Kemiri and Cinnamon + other trees according to local situation.

The associated trees frame should be the same for all trials, or similar.

Weeding : same as for rubber (6 weeding/year).

FIELD SIZE per farm

PLOT SIZE : see field maps

NUMBER OF PLOTS PER REPLICATION : 3 plots for BLIG, seedlings and clone.

NUMBER OF REPLICATION/farm : 2

DATA TO BE COLLECTED

Standard data for all RAS 2.2 :

RUBBER

- rubber growth measurements : diameter, height and whorls the first year every 3 months. Then girth the second year every 3 months. Sample of 30 trees per plot.
- Farmer's labor for each plot.
- soil samples per replication on 0-15 and 15-30 cm.
- Total number of soil samples for the 2 farms : 3 plots x 2 rep x 2 soil depths = 12

ASSOCIATED TREES

- tree growth measurements : girth every year at planting anniversary time for all trees per plot.

RICE

- date of planting
- date of harvest
- Yield of each plot with a sample of 100 grams to be sent to ICRAF/Bogor for water content measurement.
- Labor requirement per plot.

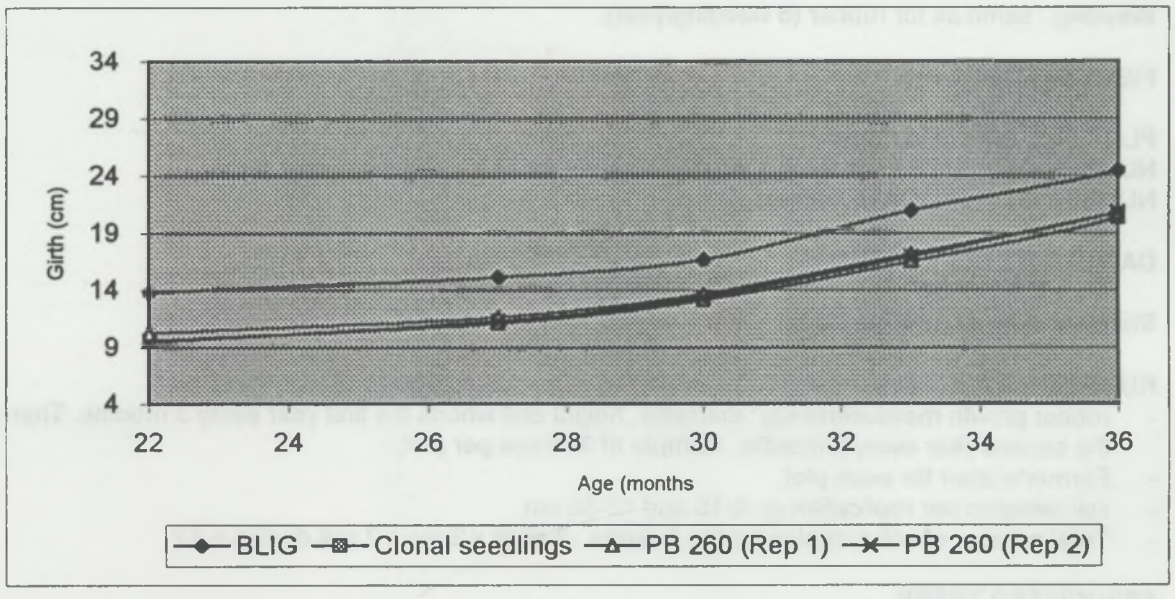
RAS 22c - WEST SUMATRA
Growth performances of different types of rubber planting material

Planting date: January 1996 - supplies in Oct 1996 - Bangkok

Farmer	Rubber type	Girth (cm)						
		Nov-97	Apr-98	Jul-98	Oct-98	Jan-99	Mar-99	Oct 00*
Budiman	BLIG	15.2	16.6	17.9	22.7	26.1	31.6	46.5
	Clonal seedlings	10.2	11.5	13.6	17.0	20.8	26.0	42.0
	PB 260 (Rep 1)	9.6	11.1	13.2	16.5	20.4	24.7	39.6
	PB 260 (Rep 2)	8.6	11.0	13.1	16.4	20.4	23.2	46.4
Udin	BLIG	12.4	13.7	15.4	19.3	22.7	26.8	44.9
	Clonal seedlings	9.1	10.6	12.7	16.0	19.9	24.8	39.8
	PB 260 (Rep 1)	10.9	12.3	14.1	17.8	21.2	24.8	39.9
	PB 260 (Rep 2)	10.4	11.7	13.8	17.5	21.1	23.8	42.8
Average	**BLIG**	**13.8**	**15.1**	**16.7**	**21.0**	**24.4**	**29.2**	**45.7**
	Clonal seedlings	**9.7**	**11.1**	**13.1**	**16.5**	**20.3**	**25.4**	**40.9**
	PB 260 (Rep 1)	**10.2**	**11.7**	**13.7**	**17.2**	**20.8**	**24.8**	**39.8**
	PB 260 (Rep 2)	**9.5**	**11.3**	**13.4**	**17.0**	**20.8**	**23.5**	**44.6**

* : New tree sample

Effect of fertilization on rubber growth



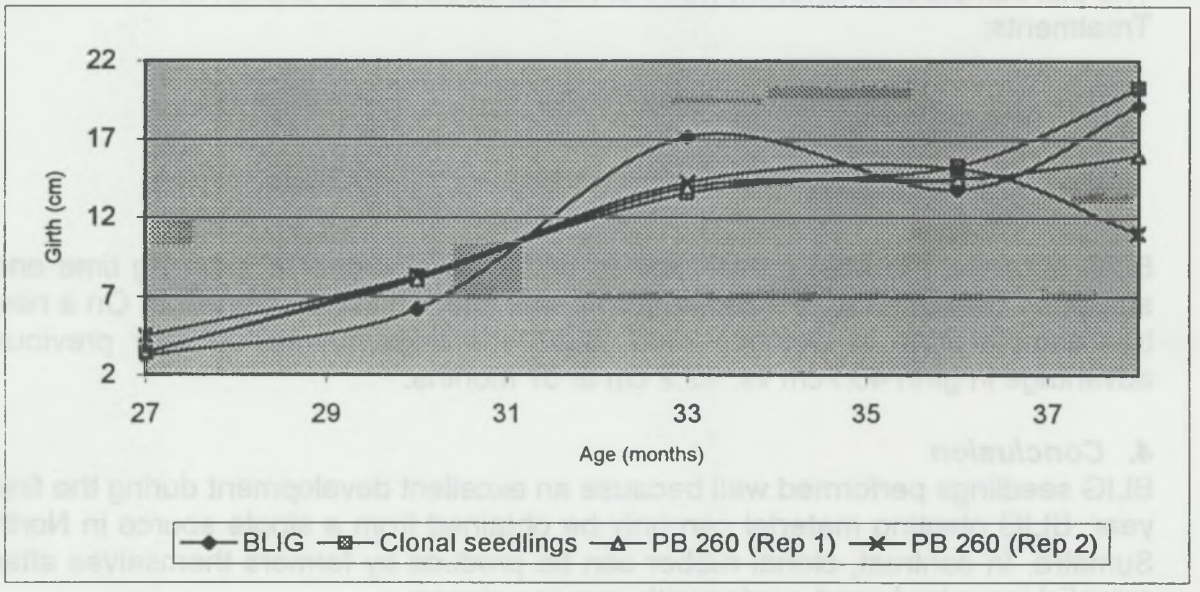
RAS 22c - WEST SUMATRA
Annual girth increment of different types of rubber planting material

Planting date: January 1996 - supplies in Oct 1996 - Bangkok

Farmer	Rubber type	Girth (cm)					
		Nov-97	Apr-98	Jul-98	Oct-98	Jan-99	Mar-99	Oct 00*
Budiman	BLIG		3.2	5.3	19.0	13.9	21.9	10.5
	Clonal seedlings		3.1	8.3	13.7	15.1	20.9	11.3
	PB 260 (Rep 1)		3.5	8.6	13.3	15.4	17.3	10.5
	PB 260 (Rep 2)		5.8	8.2	13.5	15.9	11.1	16.3
Udin	BLIG		3.2	7.0	15.3	13.7	16.4	12.8
	Clonal seedlings		3.7	8.2	13.4	15.5	19.6	10.6
	PB 260 (Rep 1)		3.4	7.5	14.6	13.5	14.5	10.7
	PB 260 (Rep 2)		3.2	8.3	15.0	14.4	10.8	13.4
Average	**BLIG**		**3.2**	**6.2**	**17.2**	**13.8**	**19.1**	**11.6**
	Clonal seedlings		**3.4**	**8.3**	**13.6**	**15.3**	**20.2**	**10.9**
	PB 260 (Rep 1)		**3.4**	**8.0**	**13.9**	**14.5**	**15.9**	**10.6**
	PB 260 (Rep 2)		**4.5**	**8.3**	**14.2**	**15.1**	**11.0**	**14.9**

* : New tree sample

Effect of fertilization on annual girth increment



WEST SUMATRA RAS 2.2 c

1. Trial implementation

The trial studies a rubber clone PB 260 compared to clonal seedlings and polyclonal seedings (BLIG). Some scientists assume that rubber seedlings are more robust and fit better smallholders farm environment than high yielding clones selected for estate conditions.

2. General observations on trial

Rubber growth is very satisfactory and BLIG well-developed seedlings at planting time maintained a development advantage over clonal rubber. After 22 months in the field, the girth difference of about 4 cm was maintained between BLIG and PB260 clone indicating that the difference is only due to an early development advantage. After 38 months the average girth increment was 9.2 cm/year for BLIG seedlings and 7.8 cm/year for PB260 clone but the average girth increment between 22 and 38 months was similar at about 9 cm/ year

3. Treatment analysis

The trial compares 3 different types of rubber seeding and clonal rubber
Treatments:

Treatment: Planting Material	Girth in cm (%)
PB 260 (2 replications)	24.2 (100)
BLIG seedlings	29.2 (121)
Clonal seedlings	25.4 (105)

BLIG obtained the best growth due to better development at planting time and sustained growth after. PB260 performs well after an initial stagnation. On a new tree sample done in October 2000, BLIG seedlings maintained their previous advantage in girth 45.7cm vs. 42.2 cm at 57 months.

4. Conclusion

BLIG seedlings performed well because an excellent development during the first year. BLIG planting material can only be obtained from a single source in North Sumatra. In contrast, clonal rubber can be produce by farmers themselves after establishing a budwood garden with genuine clones.
The average girth increment of 8.8 cm/year obtained under RAS (Rubber agroforestry systems) management on critical soils is similar to standard growth (9 cm/year) obtained in monoculture with costly inputs.

RAS TRIALS IN JAMBI

KAS TRIALS IN TAMBI

JAMBI - RAS 1.1/WEEDING

TITLE : Clonal rubber in agroforestry environment: genotype x environment interaction.

OBJECTIVE/HYPOTHESE

Objectives

- To investigate the growth of an improved rubber clone (GT 1/trial 1 and PB 260/trial 2) in close to jungle rubber conditions, under various intensities of weeding, with emphasis on the critical first 2 years of establishment.
- To compare growth of this clone under currently prescribed 'standard' (theoretically optimal) plantation management conditions (TCSDP technological package), with its growth under three variants of close to jungle rubber management (differing by increasing intensity of weeding on the rubber row). Secondary forest is allowed to grow in the inter-row.

Hypotheses

Main Hypothesis

- Increasing intensity of weeding within the rubber row (compared to that of unselected seedlings) will result in greater growth of rubber due to a decrease in intensity of below-ground competition from regenerating secondary forest species, taking into account the fact that clones required more weeding than unselected seedlings (Note : clones have never been tested in close to jungle rubber conditions).

Secondary Hypotheses

1. Increased intensity of weeding only within the row will not affect the regenerative capacity of the useful secondary forest species (e.g : fruits and timber trees, rattan....). E.g. constant disturbance will not preclude the establishment of useful secondary forest species due to e.g. dominance of grasses (or ferns). (Theoretically this disturbance should not be too detrimental to soil fertility, if slash is left as mulch as soil is still protected).
2. Increased intensity of weeding only within the row will not affect the susceptibility to invasion by Imperata, except on the row.
3. Secondary forest regrowth in the inter-row may not be more competitive than a leguminous cover crop used in the inter-row in terms of rubber growth.
4. Classical LCC used for rubber are viny species and required more weeding than natural forest regrowth.

EXPECTED OUTPUTS

- To produce recommendations on the minimum amount of weed management required for successful growth of this rubber clone in smallholder (jungle rubber) conditions for a minimum level of other inputs (use of polybagged clonal planting material and fertilization the first 2 years).

LOCATION : Jambi province, Kabupaten Muara Tebo,

TRIAL 1 with GT 1 : Kecematan Rantau Pandan, villages of Rantau Pandan (2 rep) and Muara Buat (3 rep) : total 5 replications in 4 sites/farmers in 2 villages. Planted in December 1995

TRIAL 2 with PB 260 : Kecamatan MUARA BUNGO, village of SEPPUNGGUR (6 rep) : total 6 replications in 6 sites/farmers in 2 villages. Planted in October/November 1995

DURATION

5 to 6 years for immature period. The first 2 years are critical in terms of growth and survivability. Then, if possible, a minimum of 3 years of production monitoring.

MATERIALS AND METHOD

Treatments on weeding :

first year

PLOT A Control: Prescribed 'standard' plantation management conditions (TCSDP), using leguminous cover crop, weeding (100cm on either side of the trees). Weeding : **9 times a year, the first year**

PLOT B . Regrowth of secondary forest in inter-row area, 'Low' intensity of weeding in the rubber : Whole strip weeding, 100 cm on either side of trees, **3 times a year, the first year**.

PLOT C : Regrowth of secondary forest in inter-row area, 'Medium' intensity of weeding in the rubber row: Whole strip weeding, 100cm on either side of trees, **6 times a year, the first year**

PLOT D Regrowth of secondary forest in inter-row area, 'High' intensity of weeding in the rubber row: Whole strip weeding, 100 cm on either side of trees, **9 times a year, the first year**
Plot D and A may have a different number of weeding according to weed pressure and type. Minimum level of weeding should be 6 x /year.

For the other years : see the following table :

Jambi

PLOT/year	1	2	3	4	5
A	3x	1x	0	0	0
B	6x	3x	1X	1X	1X
C	9x	6x	3x	3x	3x
D + LCC	9x + LCC	6x + LCC	3x + LCC	3x + LCC	3x + LCC

EXPERIMENTAL DESIGN

EACH TRIAL IS PROCESSED SEPARATELY with respectively 5 (1995) and 6 rep (1996).

Randomized block system: The trial 1 planted in 1995 has severally suffered from attacks of monkeys and pigs and will have only a qualitative analysis.

RUBBER FERTILIZATION

Simplfied TCSDP fertilization programme with SP 36 at planting time (115 grams per tree) and UREA (50 grams per tree, every 3 months) only for the first 2 years. No fertilization later.

SimplifiedTCSDP based fertilization programme for JAMBI is the following:
IN GRAMMES/tree

Fertilizer	Planting time October 96	+ 3 months January 97	+ 6 months April	+ 9 months July	+ 12 months October
RP	200 or 115 grams SP 36				
Urea		50	50	50	50
SP36		0	0	0	0
KCl		0	0	0	0

RUBBER PLANTING DISTANCE
Standart : 550 trees/ha : 3 x 6 meters.
Rantau Pandan (Pak Azari and Ismael) have been planted with GT1.
Muara Buat :Pak Bustami and Sariono (2 rep) have been planted with PB 260
Clone is not a treatment in that trial 1.
In Trial 2 : all rubber trees are PB 260

INTERCROPPING

TRIAL 1 : Local rice the first year (Pak Azari's plot but rice failed) or no crop (all other plots).
TRIAL 2 : no intercropping.

INTER ROW DURING IMMATURE PERIOD
The secondary forest (belukar) is allowed to grow at the conditions that trees and shrubs do not reach a height greater than that of rubber (selective cutting if necessary).

PLOT SIZE : 1000 m²
NUMBER OF PLOTS PER REPLICATION : 4 plots
REPLICATION/FARM SIZE : 4 000 m²
NUMBER OF REPLICATION
TRIAL 1 : 5 (2 with GT 1 and 3 with PB 260)
TOTAL SIZE OF THE TRIAL : 2 ha

TRIAL 2 : 6 rep (with PB 260)
TOTAL SIZE OF THE TRIAL : 2,4 ha

DATA TO BE COLLECTED

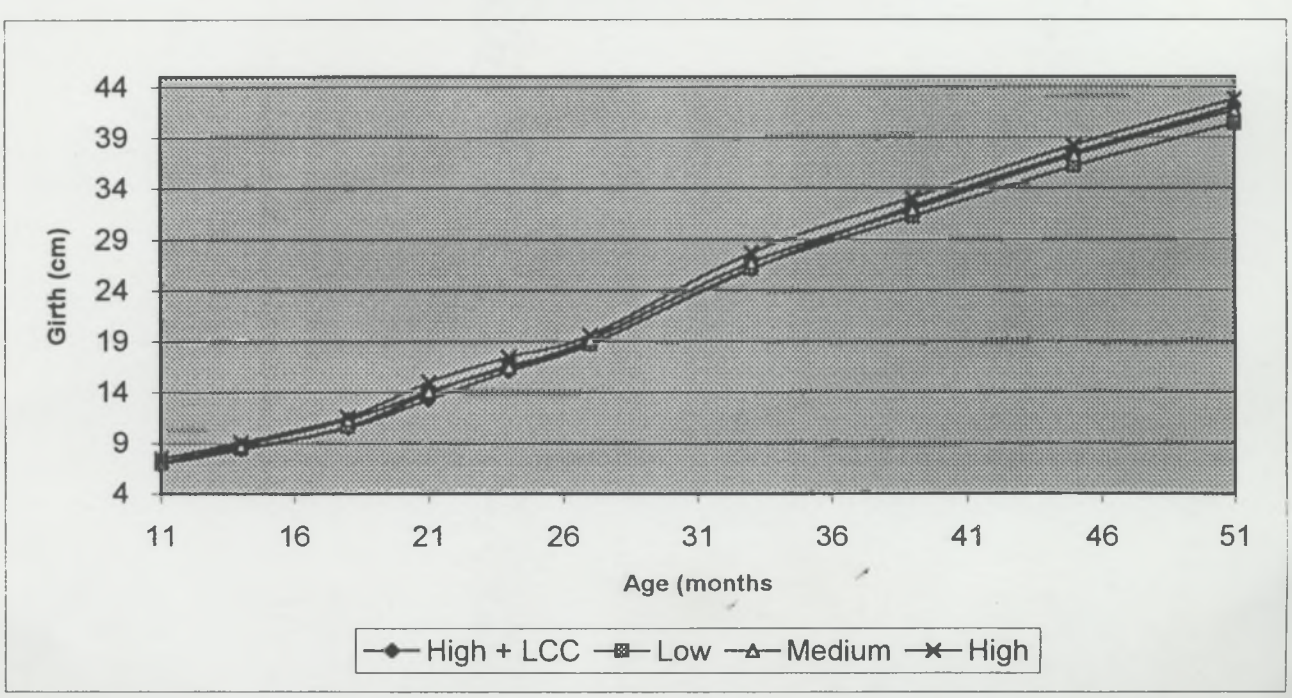
Standard data for all RAS 1:
- rubber growth measurements : diameter, height and whorls the first year every 3 months. Then girth the second year every 3 months. Samples of 30 trees per plot (10 plots per rep).
After the Year 2 : girth every planting anniversary date.
- Farmer's labor for each plot.
- soil samples per replication on 0-10 and 10-20 cm.

RAS 11 - JAMBI
Effect of weeding intensity on rubber girth

Planting date: September - October 1996 - Sepunggur

Farmer	Weeding level	Girth (cm)									
		Aug-97	Nov-97	Mar-98	Jun-98	Sep-98	Dec-98	Jun-99	Dec-99	Jun-00	Dec-00
Aljupri	High + LCC	8.4	9.3	11.4	13.6	16.1	19.9	25.5	34.0	39.3	43.9
	Low	7.8	9.3	11.3	15.0	18.0	19.4	27.4	32.2	37.9	42.6
	Medium	7.9	9.5	12.5	14.5	15.9	18.6	26.5	32.1	37.3	41.9
	High	8.1	9.7	12.0	15.6	17.9	19.2	28.6	33.9	39.4	43.7
Aroni	High + LCC	6.2	8.7	11.5	15.5	18.5	22.1	32.3	38.0	43.1	47.9
	Low	6.3	7.6	9.1	12.9	16.8	18.9	27.9	35.1	39.9	45.0
	Medium	6.2	7.8	10.8	13.5	17.1	19.3	29.0	34.4	40.8	45.8
	High	6.7	8.6	11.4	15.3	18.0	21.2	31.0	36.6	41.8	46.7
Azwar	High + LCC	5.2	6.4	7.8	9.6	12.0	13.2	19.1	24.5	29.9	34.5
	Low	5.9	7.4	9.5	11.1	13.9	14.3	19.1	23.2	27.2	30.4
	Medium	5.9	8.1	10.2	12.1	13.8	16.1	22.0	27.1	32.9	37.0
	High	6.8	8.1	10.3	12.4	14.1	15.8	22.3	26.8	32.0	36.5
Eman	High + LCC	7.3	8.5	11.4	14.0	17.0	19.4	26.7	32.6	38.0	42.4
	Low	6.5	7.6	9.9	13.2	14.5	17.3	23.7	27.7	32.2	36.5
	Medium	7.0	8.3	10.5	14.0	15.8	18.9	25.6	31.2	35.9	40.1
	High	7.2	8.6	11.2	14.3	17.4	19.5	26.7	33.4	38.0	42.3
Sahroni	High + LCC	6.6	8.5	10.1	12.9	15.9	18.3	25.5	30.2	36.0	40.6
	Low	8.1	9.8	12.6	16.5	19.6	22.0	30.0	35.3	40.5	44.0
	Medium	8.2	10.0	12.7	15.6	19.3	22.3	30.3	34.4	39.3	43.4
	High	8.5	10.4	12.7	16.2	18.9	21.4	29.1	34.5	39.2	43.6
Zulkafri	High + LCC	8.3	8.7	10.7	14.1	16.6	19.2	27.0	33.7	38.6	43.1
	Low	7.0	9.0	11.2	14.9	16.8	20.2	28.3	33.5	39.3	44.0
	Medium	7.0	8.9	11.0	14.7	17.0	19.7	27.1	32.1	37.5	41.8
	High	7.6	9.3	11.8	15.9	18.3	20.5	28.2	33.2	38.9	43.9
Average	**High + LCC**	**7.0**	**8.3**	**10.5**	**13.3**	**16.0**	**18.7**	**26.0**	**32.2**	**37.5**	**42.1**
	Low	**6.9**	**8.5**	**10.6**	**13.9**	**16.6**	**18.7**	**26.0**	**31.2**	**36.2**	**40.4**
	Medium	**7.0**	**8.8**	**11.3**	**14.1**	**16.5**	**19.1**	**26.7**	**31.9**	**37.3**	**41.7**
	High	**7.5**	**9.1**	**11.5**	**15.0**	**17.4**	**19.6**	**27.6**	**33.0**	**38.2**	**42.8**

Effect of weeding on rubber growth



RAS 11 - JAMBI

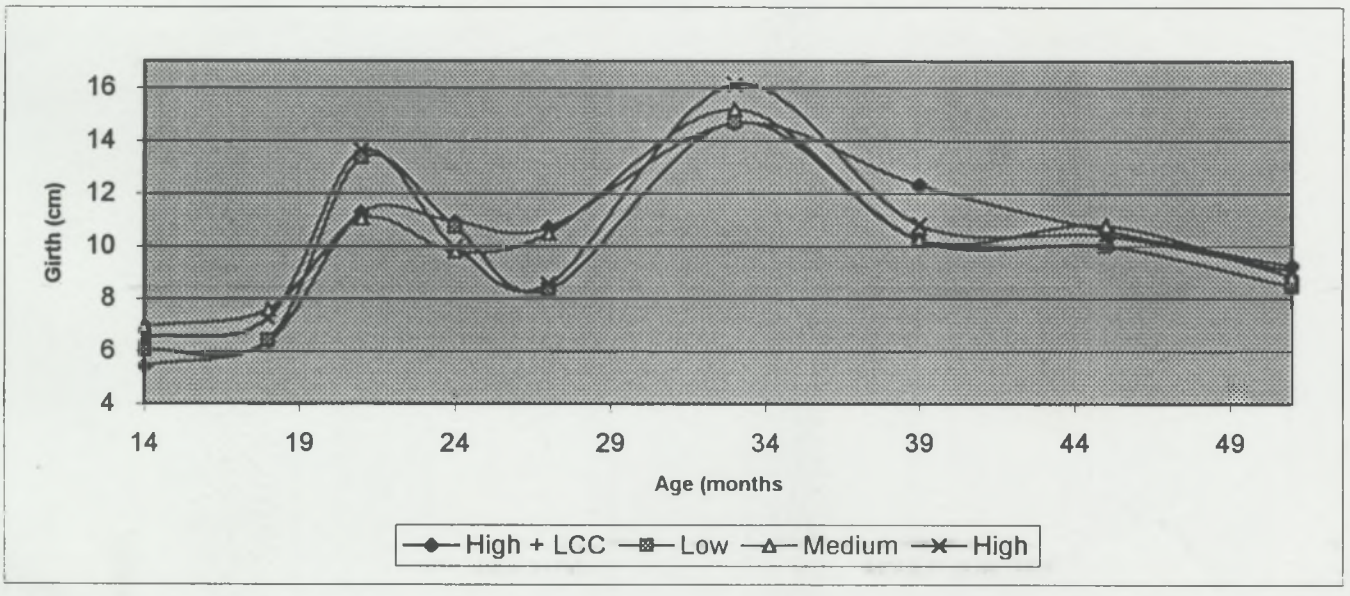
Effect of weeding intensity on annual girth increment of rubber

Planting date: September - October 1996 - Sepunggur

Farmer	Weeding level	Annual girth increment (cm)								
		Aug-97	Nov-97	Mar-98	Jun-98	Sep-98	Dec-98	Jun-99	Dec-99	Jun-00	Dec-00
Aljupri	High + LCC	3.7	6.3	8.6	10.2	15.4	11.2	16.9	10.6	9.3
	Low	6.2	5.9	14.9	12.0	5.4	16.0	9.7	11.3	9.4
	Medium	6.5	9.0	7.8	5.9	10.5	15.8	11.2	10.4	9.2
	High	6.4	6.6	14.5	9.4	5.1	18.8	10.6	11.1	8.5
Aroni	High + LCC	10.0	8.4	16.1	11.9	14.4	20.3	11.5	10.1	9.6
	Low	4.9	4.5	15.2	15.8	8.5	17.8	14.5	9.6	10.1
	Medium	6.2	9.2	10.7	14.5	8.5	19.5	10.7	12.8	10.1
	High	7.7	8.3	15.7	11.0	12.6	19.6	11.1	10.6	9.7
Azwar	High + LCC	4.9	4.2	7.1	9.7	4.7	11.9	10.8	10.6	9.4
	Low	5.8	6.3	6.8	11.2	1.6	9.5	8.1	8.1	6.3
	Medium	8.6	6.5	7.4	7.1	8.9	11.8	10.3	11.6	8.3
	High	5.1	6.7	8.5	6.5	6.8	13.1	8.9	10.5	9.0
Eman	High + LCC	4.8	8.5	10.8	11.7	9.8	14.6	11.7	10.8	8.9
	Low	4.3	7.0	12.9	5.3	11.1	12.8	8.0	9.0	8.7
	Medium	5.2	6.6	14.0	7.3	12.2	13.5	11.2	9.4	8.5
	High	5.7	7.7	12.3	12.7	8.2	14.5	13.3	9.2	8.7
Sahroni	High + LCC	7.8	4.8	11.2	11.9	9.6	14.4	9.5	11.4	9.3
	Low	7.0	8.3	15.6	12.3	9.7	16.0	10.6	10.4	6.9
	Medium	7.4	8.0	11.8	14.7	11.9	16.0	8.2	9.7	8.2
	High	7.5	6.9	14.1	10.9	9.8	15.5	10.8	9.5	8.7
Zulkafri	High + LCC	1.4	6.0	13.7	10.1	10.3	15.6	13.4	9.9	9.0
	Low	8.0	6.5	14.7	7.8	13.8	16.1	10.4	11.6	9.5
	Medium	7.9	6.2	14.7	9.3	10.9	14.6	10.1	10.9	8.6
	High	6.7	7.4	16.7	9.3	8.8	15.4	10.0	11.4	9.9

Average	**High + LCC**	**5.4**	**6.4**	**11.3**	**10.9**	**10.7**	**14.7**	**12.3**	**10.6**	**9.2**
	Low	**6.0**	**6.4**	**13.3**	**10.7**	**8.3**	**14.7**	**10.2**	**10.0**	**8.5**
	Medium	**6.9**	**7.6**	**11.0**	**9.8**	**10.5**	**15.2**	**10.3**	**10.8**	**8.8**
	High	**6.5**	**7.3**	**13.6**	**10.0**	**8.6**	**16.1**	**10.8**	**10.4**	**9.1**

Effect of weeding on annual girth increment



RAS 11- JAMBI
Rubber girth at 51 months

Farmer	High+LCC	Low	Medium	High
Aljupri	43.93	42.55	41.90	43.66
Aroni	47.86	44.96	45.80	46.67
Azwar	34.55	30.37	37.03	36.52
Eman	42.45	36.49	40.14	42.34
Sahroni	40.61	43.99	43.36	43.57
Zulkafri	43.11	43.99	41.81	43.86

Anova: Two-Factor Without Replication

SUMMARY	*Count*	*Sum*	*Average*	*Variance*
Aljupri	4	172.04	43.01	0.91
Aroni	4	185.29	46.32	1.54
Azwar	4	138.47	34.62	9.16
Eman	4	161.42	40.36	7.76
Sahroni	4	171.53	42.88	2.37
Zulkafri	4	172.77	43.19	1.00
High+LCC	6	252.50	42.08	19.39
Low	6	242.36	40.39	33.40
Medium	6	250.05	41.67	8.77
High	6	256.62	42.77	11.43

lsd 5% = 2.251
lsd 1% = 3.113

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*	
Farmer	314.6775	5	62.94	18.80	5.54626E-06	2.90	**
Weeding	17.994719	3	6.00	1.79	0.191839062	3.29	
Error	50.202905	15	3.35				
Total	382.87512	23					

JAMBI - RAS 1.1

1. Trial implementation

In participatory research with smallholders, it is difficult to maintain strict standard of maintenance according to schedule. Deviations from original protocol, behavior of farmers and acceptance of innovations are precious inputs used in technical recommendation formulation. Maintenance was strictly followed in year 1 then, it was less strictly applied in year 2 and 3. Some slashing of vegetation in the interrow was done by farmers thinking that it will to prevent damages caused by wild pigs.

2. General observations on trial

Rubber growth is very satisfactory and similar to standard for rubber monoculture 9.8 cm/year of girth increment vs. a standard of 9 cm/year. Natural vegetation re-growth composed mainly of shrubs; *Chromolaena* and *Melastoma* and some ferns, which did not affect rubber growth.

Girth increment was low during the dry season (June to September) in 1997 and 1998, showing real impact of water deficit on rubber growth during the early development stages.

3. Treatment analysis

The trial compares various level of weeding with different frequency of weeding on rubber row.

rubber girth at 51 months

Treatment	Girth in cm (%)
A: Intensive weeding and LCC in the interrow girth	42.2 (100)
B: Low intensity weeding and natural vegetation regrowth	40.4 (96)
C: Medium intensity and natural vegetation regrowth	41.7 (99)
D: High intensity and natural vegetation regrowth	42.8 (102)

Statistic analysis indicates that that there are no significant differences between treatments but significant differences exist between farms. In fields where *Imperata cylindrica* is not widely present, a reduction of weeding round frequency is possible and the rubber growth is definitely not affected. Clonal rubber is perfectly adapted to such environment.

4. Conclusions

A maintenance schedule of 4 weedings a year (by slashing or chemical weeding) is sufficient to obtain a standard rubber growth. As natural re-growth is allowed in the interrow it is expected that part of the original biodiversity will re-establish in the fields. It is now confirmed that the re-growth of shrubs and trees helps to prevent *imperata* and grasses development. Natural vegetation return is not uniform and it establishes better if old jungle rubber surrounds rubber plots.

JAMBI - RAS 1.2/CLONE COMPARISON

TITLE : Clonal rubber and unselected seedlings in agroforestry environment

Clonal rubber and unselected seedlings in agroforestry environment: genotype x environment interaction.
2 treatments : Clone comparison (4 clones + seedlings) with 2 levels of weeding.

OBJECTIVE/HYPOTHESE

Objectives

- To investigate the growth of 4 improved rubber clone (with PB 260 and unselected seedlings as controls) in RAS 1 environment (close to jungle rubber conditions), under 2 intensities of weeding, with emphasis on the critical first 2 years of establishment.

Hypotheses

Main Hypothesis

- Increasing intensity of weeding within the rubber row (compared to that of unselected seedlings) will result in greater growth of rubber due to a decrease in intensity of below-ground competition from regenerating secondary forest species, taking into account the fact that clones required more weeding than unselected seedlings (Note : clones have never been tested in close to jungle rubber conditions).
- It is necessary to rely on several clones rather than only one to limit risks and increase adaptability of clonal planting material in jungle rubber conditions. It may be expected that jungle rubber conditions increase the risk of leaf diseases compared to that of monoculture due to higher moisture level and microclimatic conditions more favorable to fungus development.

Some clones may be more adapted than other for RAS 1 among those 4 clones, which have been selected for all RAS trials. The performances of clones will be compared to that of unselected seedlings and PB 260, which is considered as the clone benchmark.

EXPECTED OUTPUTS

- To produce recommendations on clonal recommendations in RAS 1.

LOCATION : Jambi, Kamubaten Muara Tebo.
Also in West-Kalimantan province, Kabupaten Sanggau, Kecamatan Sanggau Kapuas, villages of Embaong.
Total 6 replications for October 1996 planting.

YEAR :
In polybags : July 1996 with Goodyear planting material in West-Kalimantan and Jambi.
planting of rubber : October 1996

DURATION

5 to 6 years for immature period. The first 2 years are critical in terms of growth and survivability. Then, if possible, a minimum of 3 years of production monitoring.

MATERIALS AND METHOD

Design: 10 plots Treatments

Treatment 1: clones (4) and unselected seedlings (1): 5 type of planting material
Treatment 2: weeding intensity:
Year 1:3 and 6 weeding/year
(Note that the weeding treatment is 4 and 8 weedings/year in West-Kalimantan).

TRIAL DESIGN

PB 260 3 weeding/year	RRIC 100 3 weeding/year	BPM 1 3 weeding/year	RRIM 600 3 weeding/year	Unselected seedings 3 weeding/year
PB 260 6 weeding/year	RRIC 100 6 weeding/year	BPM 1 6 weeding/year	RRIM 600 6 weeding/year	Unselected seedings 6 weeding/year

The 2 series of clones and unselected seedings will be randomized in the strip. The 2 strips are randomised (strip split plot design). For the farmer ; only 2 visible plots with 2 levels of weeding. Level of weeding is not fully randomized for pratical reasons.

Year 2 an later :
For RAS 1.2

PLOT/year	1	2	3	4	5
A	4x	2x	1x	1x	1x
B	8x	4x	3X	3X	3X

EXPERIMENTAL DESIGN

Strip split-plot with main treatment on clones, secondary treatment on weeding level.
Control is PB 260 plot.

RUBBER CLONES

Fast growing clones: PB 260 and RRIC 100
Medium growth clones: BPM 1 and RRIM 600

FERTILIZATION

TCSDP fertilization program:
- 200 grams of RP or 115 grams of SP 36 per trees at planting time.
- 50 grams of urea (N) per tree every 3 months only for the first year only. No fertilization later.

Simplified TCSDP based fertilization program for JAMBI is the following:

in g/tree

	Planting time October 96	+ 3 months January 97	+ 6 months April	+ 9 months July	+ 12 months October
RP	200 or 115 grams SP 36				
Urea		50	50	50	50
SP36		0	0	0	0
KCl		0	0	0	0

RUBBER PLANTING DISTANCE
Standard: 550 trees/ha : 3 x 6 meters.

INTERCROPPING
Nothing or local rice the first year (with some palawijas such as corn and cassava). No fertilization of intercrops the year 1.
In Jambi : no intercrops.
Note that rice may be cropped and fertilized in RAS 1/CC in Kalimantan.

INTER ROW DURING IMATURE PERIOD
The secondary forest (belukar) is allowed to grow at the conditions that trees and shrubs do not reach a height greater than that of rubber (selective cutting if necessary according to field situation).

DESIGN

PLOT SIZE :	800 m²
NUMBER OF PLOTS PER REPLICATION :	10 plots
REPLICATION/FARM SIZE :	8 000 m²
NUMBER OF REPLICATION per trial =	6 rep (1 farm is 1 rep)
TOTAL SIZE OF 1TRIAL :	4.8 ha
Location :	Sepunggur

Note : A replication can be split into 2 fields with 2 clones and seedlings

DATA TO BE COLLECTED

Standard data for all RAS 1 :
- rubber growth measurements : diameter, height and whorls the first year every 3 months. Then girth the second year every 3 months. Sample of 30 trees per plots (10 plots per rep).
After the Year 2 : girth every planting anniversary date.
- Farmer's labor for each plot. Monitoring of labor with the 'buku buruh" distributed to each farmers..
- soil samples per replication on 0-15 and 15-40 cm.
- rice production if any (West Kalimantan).
Labor requirement per plot recorded in buku buruh.

PLOT RANDOMIZATION FOR JAMBI

1 Pak MAOWI

TRENCH EXP	BPM 1	RRIM 600	Seedlings	PB 260	RRIC 100	3X
PB 260	BPM 1	HOLE NOT USED	RRIM 600	RRIC 100	Seedlings	6X

2 PAK HADJI DUR

SEEDLINGS	RRIC 100	BPM 1	RRIM 600	PB 260	3X
BPM 1	PB 260	RRIM 600	RRIC 100	SEEDLINGS	6X

JALAN

3.1 PAK HARARAP : half rep

seedlings	RRIM 600	BPM 1	3X
SEEDLINGS	BPM 1	RRIM 600	6X

RIVER

3.2 PAK YUSUF : half replication

seedlings	RRIC 100	PB 260	3x
PB 260	RRIC 100	seedlings	6X

Jalan

4 PAK TARIDI

PB 260	RRIC 100	RRIM 600	Seedlings	BPM 1	3X
BPM 1	RRIC 100	PB 260	RRIM 600	seedlings	6X

JALAN

5 Pak ABDUL RONI

Seedlings	RRIC 200	PB 260	BPM 1	RRIM 600	3X
PB 260	BPM 1	seedlings	RRIM 600	RRIC 100	6X

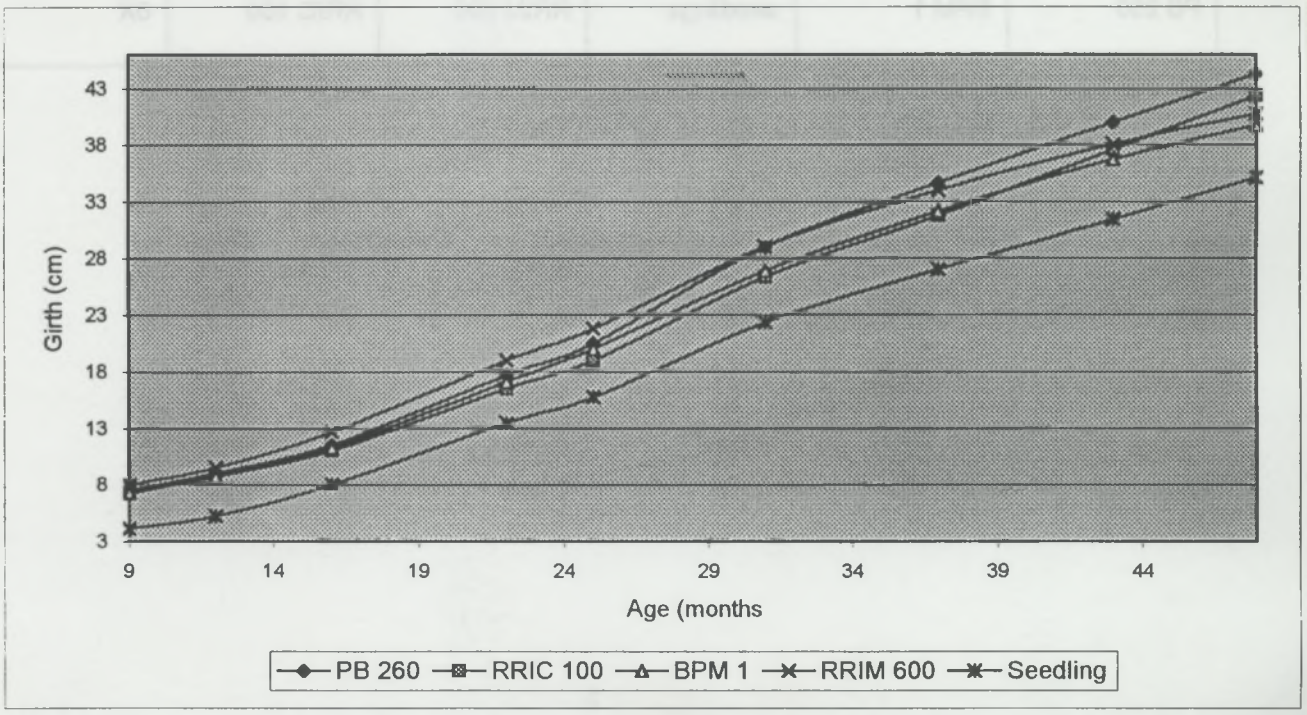
RAS 12 - JAMBI

Performances of different rubber clones in near jungle rubber environment (RAS1)

Planting date: November 1996 - Muara Buat

Farmer	Rubber Clone	Girth (cm)																	
		Low weeding									High weeding								
		Au97	Nv97	Mr98	Sp98	Dc98	Jn99	Dc99	Jn00	Nv00	Au97	Nv97	Mr98	Sp98	Dc98	Jn99	Dc99	Jn00	Nv00
A. Roni	PB 260	6.6	8.5	11.0	17.9	20.6	29.5	35.0	40.4	45.0	8.3	9.8	12.0	19.3	22.1	31.1	37.2	42.7	47.0
	RRIC 100	8.0	9.9	12.2	18.8	20.8	28.7	34.6	40.2	45.1	9.8	10.1	12.4	18.9	21.9	30.1	36.3	41.7	46.9
	RRIM 600	8.3	9.8	12.3	18.4	21.6	29.7	35.0	39.0	42.6	8.7	10.0	12.9	19.6	22.2	29.2	34.4	38.4	42.4
	BPM 1	8.5	10.1	13.6	21.9	25.3	33.4	38.5	42.6	46.0	8.6	10.1	13.4	20.5	23.8	31.5	36.3	41.2	45.0
	Seedling	4.3	5.5	8.7	14.8	16.5	23.6	29.4	34.6	39.3	3.8	5.5	7.9	14.4	16.4	23.7	28.4	33.5	37.7
M Lutan	PB 260	6.5	7.9	10.5	15.6	18.1	26.5	31.5	37.4	41.6	6.6	8.3	10.9	16.3	19.6	28.3	34.5	39.6	44.0
	RRIC 100	4.0	6.0	8.0	12.4	14.2	19.9	24.7	30.8	35.5	5.0	6.3	8.7	12.9	15.3	22.1	27.1	33.7	38.7
	RRIM 600	5.1	6.3	8.6	13.5	15.9	21.1	24.7	28.3	29.5	5.9	7.3	10.1	15.6	18.2	25.1	29.3	34.0	36.2
	BPM 1	5.3	7.0	10.4	15.8	18.8	25.4	29.9	32.6	33.9	6.8	8.1	11.2	16.0	19.0	26.9	32.3	37.3	40.9
	Seedling	3.1	4.0	6.5	11.2	13.9	19.0	23.0	26.4	29.3	3.1	4.5	7.4	12.7	14.9	21.5	26.3	30.3	33.9
Taridi	PB 260	8.1	9.6	12.3	18.0	20.5	28.5	33.3	38.6	42.6	8.7	10.1	12.5	19.1	22.0	30.0	35.9	41.3	45.4
	RRIC 100	7.9	9.9	12.0	17.5	20.2	27.7	32.4	37.8	42.5	8.5	10.2	12.8	18.6	21.7	29.5	35.3	41.2	45.3
	RRIM 600	7.6	8.6	11.4	16.7	20.7	26.8	33.5	39.2	42.2	8.3	10.0	12.4	18.7	21.5	29.4	35.7	41.2	45.4
	BPM 1	9.3	10.7	13.5	20.0	21.4	28.5	33.1	37.1	39.2	9.3	11.1	13.8	19.7	22.3	28.6	33.5	37.4	39.5
	Seedling	4.2	5.5	8.4	13.1	15.7	23.2	27.6	32.9	36.7	6.2	6.3	9.1	14.8	17.1	23.0	27.4	30.6	33.7
Yusuf	PB 260	6.8	11.0	11.3	20.0	22.5	28.2	30.7	36.1	36.3	9.2	10.7	14.2	17.6	18.9	25.7	32.3	34.5	37.3
	RRIC 100	8.7	11.8	13.4	18.6	20.9	27.4	32.4	35.8	37.3	9.8	10.7	14.1	18.9	20.4	27.6	32.5	35.6	38.2
	Seedling	6.8	6.9	11.3	12.7	14.7	20.3	27.9	26.6	31.7	4.4	8.6	9.9	16.9	19.7	23.7	23.7	29.9	29.9
Average	PB 260	7.1	8.7	11.3	17.2	19.7	28.1	33.3	38.8	43.1	7.9	9.4	11.8	18.2	21.2	29.8	35.9	41.2	45.5
	RRIC 100	6.6	8.6	10.7	16.3	18.4	25.4	30.6	36.3	41.1	7.8	8.9	11.3	16.8	19.6	27.2	32.9	38.9	43.6
	RRIM 600	7.0	8.2	10.7	16.2	19.4	25.9	31.1	35.5	38.1	7.6	9.1	11.8	18.0	20.6	27.9	33.1	37.9	41.3
	BPM 1	7.7	9.3	12.5	19.2	21.8	29.1	33.9	37.4	39.7	8.2	9.8	12.8	18.8	21.7	29.0	34.0	38.6	41.8
	Seedling	3.9	5.0	7.8	13.0	15.4	21.9	26.7	31.3	35.1	4.4	5.4	8.2	14.0	16.1	22.7	27.3	31.5	35.1

Rubber growth according to clone



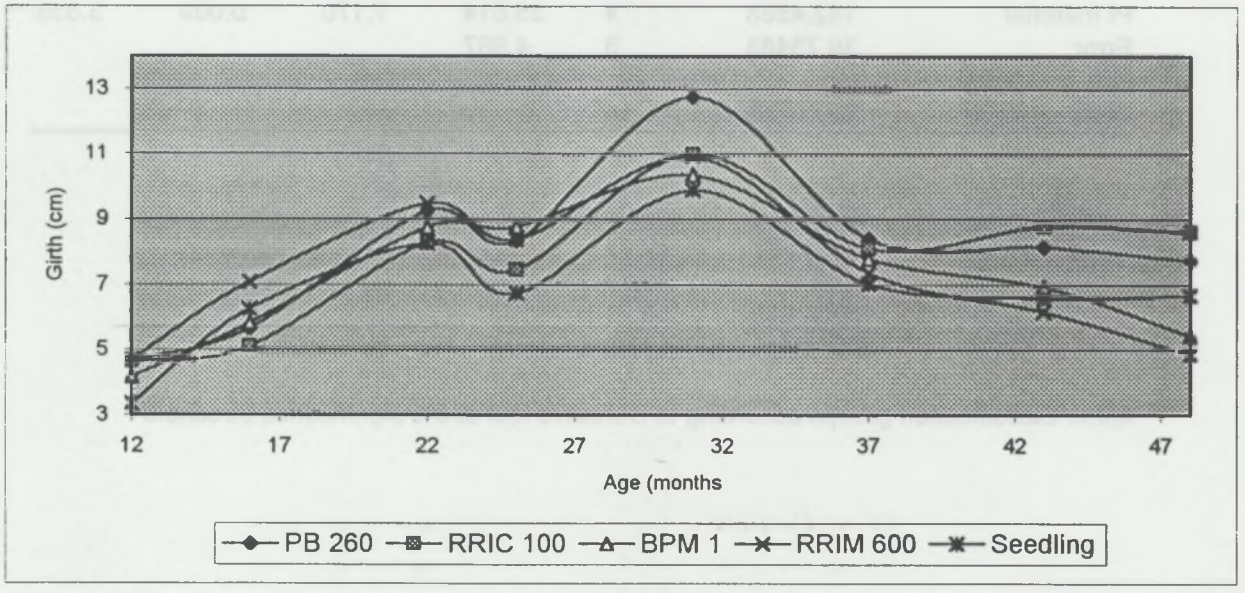
RAS 12 - JAMBI

Annual girth increment in different rubber clones

Planting date: November 1996 - Muara Buat

Farmer	Rubber clone	Annual girth increment															
		Low weeding								High weeding							
		Nv97	Mr98	Sp98	Dc98	Jn99	Dc99	Jn00	Nv00	Nv97	Mr98	Sp98	Dc98	Jn99	Dc99	Jn00	Nv00
A. Roni	PB 260	7.5	7.5	13.8	10.7	17.8	11.2	10.7	11.2	6.0	6.5	14.6	11.2	18.2	12.1	11.0	10.3
	RRIC 100	7.5	6.9	13.3	7.7	15.8	11.9	11.3	11.7	1.1	7.0	13.0	11.9	16.5	12.3	10.8	12.4
	RRIM 600	6.0	7.4	12.4	12.7	16.2	10.6	7.9	8.7	5.5	8.7	13.4	10.2	14.1	10.4	8.1	9.5
	BPM 1	6.5	10.7	16.5	13.6	16.1	10.4	8.1	8.1	6.3	9.8	14.2	13.1	15.4	9.5	9.9	9.1
	Seedling	5.0	9.5	12.2	7.0	14.1	11.6	10.5	11.1	6.9	7.2	13.1	7.7	14.7	9.4	10.2	10.2
M Lutan	PB 260	5.6	7.9	10.2	10.0	16.7	10.0	11.8	10.0	6.9	7.7	10.9	12.9	17.5	12.4	10.1	10.8
	RRIC 100	8.0	5.9	9.0	7.0	11.5	9.5	12.2	11.4	5.6	7.1	8.4	9.5	13.6	10.1	13.2	12.0
	RRIM 600	4.8	6.7	9.9	9.7	10.4	7.1	7.3	2.7	5.9	8.4	11.0	10.3	13.8	8.3	9.4	5.1
	BPM 1	7.0	10.2	10.7	12.2	13.1	9.1	5.5	3.1	5.3	9.3	9.6	11.9	15.8	10.7	10.1	8.6
	Seedling	3.8	7.3	9.6	10.5	10.2	8.1	6.9	7.0	5.5	8.8	10.5	9.0	13.2	9.5	8.1	8.6
Taridi	PB 260	5.8	8.3	11.4	9.9	15.9	9.6	10.7	9.6	5.5	7.3	13.1	11.9	15.8	11.8	10.9	9.9
	RRIC 100	7.9	6.3	11.0	10.8	15.0	9.4	10.8	11.3	7.0	7.8	11.6	12.6	15.5	11.5	11.8	9.8
	RRIM 600	4.1	8.3	10.7	16.1	12.2	13.3	11.5	7.1	7.0	7.0	12.7	11.1	15.9	12.6	11.0	10.1
	BPM 1	5.6	8.5	12.8	5.8	14.2	9.3	7.8	5.2	6.9	8.2	11.9	10.2	12.6	9.9	7.8	4.9
	Seedling	5.1	8.6	9.4	10.4	15.0	8.8	10.6	9.1	0.5	8.5	11.4	9.0	11.8	8.7	6.6	7.3
Yusuf	PB 260	17.0	0.9	17.4	10.0	11.4	5.0	10.8	0.4	5.9	10.5	6.7	5.3	13.6	13.2	4.4	6.6
	RRIC 100	12.4	4.8	10.4	9.3	13.0	9.9	6.8	3.6	3.8	10.1	9.5	6.1	14.4	9.9	6.1	6.4
	Seedling	0.3	13.1	2.9	7.7	11.3	12.6	2.6	9.0	16.8	3.9	14.1	11.1	8.0	6.1	6.5	2.3
Average	**PB 260**	**4.7**	**5.9**	**8.9**	**7.7**	**12.6**	**7.7**	**8.3**	**7.7**	**4.6**	**5.4**	**9.6**	**9.0**	**12.9**	**9.1**	**8.0**	**7.7**
	RRIC 100	**5.9**	**4.8**	**8.3**	**6.4**	**10.6**	**7.7**	**8.6**	**8.6**	**3.4**	**5.5**	**8.2**	**8.5**	**11.4**	**8.5**	**9.0**	**8.6**
	RRIM 600	**3.7**	**5.6**	**8.2**	**9.6**	**9.7**	**7.7**	**6.7**	**4.6**	**4.6**	**6.0**	**9.3**	**7.9**	**11.0**	**7.8**	**7.1**	**6.2**
	BPM 1	**4.8**	**7.3**	**10.0**	**7.9**	**10.9**	**7.2**	**5.4**	**4.1**	**4.6**	**6.8**	**8.9**	**8.8**	**11.0**	**7.5**	**6.9**	**5.7**
	Seedling	**3.5**	**6.4**	**7.8**	**7.0**	**9.8**	**7.1**	**7.0**	**6.8**	**3.2**	**6.1**	**8.7**	**6.4**	**9.9**	**6.9**	**6.2**	**6.5**

Rubber growth according to clone



RAS 12 - JAMBI

Girth of different clones at 48 months

Farmer		PB 260	RRIC 100	RRIM 600	BPM 1	Seedling
Low weeding	A Roni	45.0	45.1	42.6	46.0	39.3
	M Lutan	41.6	35.5	29.5	33.9	29.3
	Taridi	42.6	42.5	42.2	39.2	36.7
High weeding	A Roni	47.0	46.9	42.4	45.0	37.7
	M Lutan	44.0	38.7	36.2	40.9	33.9
	Taridi	45.4	45.3	45.4	39.5	33.7
Average	**A Roni**	**46.0**	**46.0**	**42.5**	**45.5**	**38.5**
	M Lutan	**42.8**	**37.1**	**32.8**	**37.4**	**31.6**
	Taridi	**44.0**	**43.9**	**43.8**	**39.3**	**35.2**

Anova: Two-Factor Without Replication

SUMMARY	*Count*	*Sum*	*Average*	*Variance*		
A Roni	5	218.48	43.70	10.56		
M Lutan	5	181.76	36.35	19.58		
Taridi	5	206.23	41.25	15.41		
PB 260	3	132.83	44.28	2.61		
RRIC 100	3	127.01	42.34	21.49		
RRIM 600	3	119.13	39.71	36.13	lsd 5% =	4.196
BPM 1	3	122.20	40.73	17.73	lsd 1% =	6.105
Seedling	3	105.29	35.10	11.81		

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*	
Farmer	139.7844	2	69.892	14.072	0.002	4.459	**
PI material	142.4568	4	35.614	7.170	0.009	3.838	**
Error	39.73483	8	4.967				
Total	321.9761	14					

PB 260	44.28	a
RRIC 100	42.34	a
BPM 1	40.73	a
RRIM 600	39.71	b
Seedling	35.10	c

a,b,c: Classification groups according to Duncan's test at 5% significance threshold

JAMBI - RAS 1.2

1. Trial implementation

The trial studies different rubber clones compared to rubber seedlings. Rubber plants were weeded at low and more intense weeding to study eventual sensitivity of rubber clones to favorable environmental conditions.

2. General observations on trial

Rubber growth is very satisfactory and similar to standard for rubber monoculture in clonal material 10.7 cm/year of girth increment vs. a standard of 9 cm/year. Seedlings that obtained an annual girth growth of 8.7 cm/year are inferior to rubber clones.

Girth increment was low during the dry season (June to September) in 1997 and 1998, showing real impact of water deficit on rubber growth during the early development stages.

3. Treatment analysis

The trial compares 5 different types of rubber and two levels of weeding Treatments:

Treatment Planting Material	Girth in cm (%)
PB 260	44.3 (100)
RRIC 100	42.3 (96)
RRIM 600	39.7 (90)
BPM 1	40.7 (92)
Seedling	35.1 (79)
Treatment Weeding intensity	
Low Intensity	39.4 (100)
High intensity	41.5 (105)

Statistic analysis indicates significant differences between treatments (planting material) and between farms. All rubber clones grow significantly faster than rubber seedlings. Intensive weeding didn't significantly improve rubber growth

4. Conclusion

Rubber clones performed well under RAS 1 in conditions close to secondary forest environment. Limited maintenance didn't affect rubber growth, and performances compare favorably with rubber plantation standard. PB 260 and RRIC 100 have a better growth than RRIM 600 and BPM1.

BPM 1 had an early wintering (leaf fall) in June 1999 which consequently affected growth during year 2000 (6 cm/year vs. 8.5 cm/year for other clones). The use of fast growing clones like PB 260 and RRIC 100 ensures early production and good profitability.

JAMBI - RAS 1.3/ RUBBER FERTILIZATION

TITLE

Clonal rubber in RAS 1 type agroforestry environment: rubber + secondary forest regrowth. Treatment on rubber only

OBJECTIVE/HYPOTHESE

Objectives

Rubber is planted at normal planting density of 550/ha in a RAS 1 type trial (cf RAS 1 protocol). Fertilization of rubber may be a key factor in the trade-off between fertilization/higher cost of establishment, the level of weeding (studied in RAS 1) and the good and fast growth of trees to compete with the natural forest regrowth in the inter-rows.

This trial is aimed to compare 4 amounts of fertilization on clonal rubber in RAS 1 system.

Hypotheses :

In the specific conditions of Jambi, rubber fertilization may be required to obtain a fast growth performance. Good rubber growth performance may lead to early opening.

EXPECTED OUTPUTS

To produce recommendations on fertilization component of RAS 1:

- rubber fertilization management required for successful growth of rubber clone in this environment

LOCATION : Jambi, village of Rantau Pandan

YEAR : planting of rubber : October 1996

DURATION

5 to 6 years for immature period. The first 2 years are critical in terms of growth and survivability.

MATERIALS AND METHOD

Rubber + secondary forest regrowth: on all plots.

Treatments : on rubber fertilization

***PLOT A :* "0 fertilization"**

***PLOT B :* " application of high amount of Rock Phosphate (RP) at planting time only** (1 ton /ha or RP, 27.5 % in the planting hole and 72.5 % broadcast in the field at planting time) So:

- in the planting hole : 500 grams per trees (275 kg/ha)
- broadcast in the field at planting time : 725 kg/ha

***PLOT C :* selective TCSDP fertilization program for the first 2 years :** with 115 grams/tree of SP 36 at planting time and 50 grams/tree of urea every 3 months.

***PLOT D :* complete TCSDP fertilization program for the first 2 years** with SP 36 at planting time and NPK fertilization every 3 months).

The TCSDP fertilization program is the following:

In g/tree

	Planting time October 96	+ 3 months January 97	+ 6 months April	+ 9 months July	+ 12 months October
RP					
Urea		50	50	50	50
SP36	115	40	40	40	40
KCl			40	40	40

The amount of each fertilizer to be supplied to the plots is calculated in annex for each farmer and for each plot.

Note: this trial is similar to that of RAS 2.2a in West-Sumatra in term of rubber fertilization (with 1 level added: simplified TCSDP FERTILIZATION), but the environment (and the management) is different (RAS 2.2 in West-Sumatra and RAS 1 in Jambi).

EXPERIMENTAL DESIGN
Randomized block system
2 replications.1 farm only.

RAS 1.3/RUBBER FERTILIZATION : Pak Maowi

A1	***C2***	***not used***	***D2***	***C1***
B2	***D1***	***not used***	***B1***	***A2***

RUBBER
All rep are planted with PB 260

FERTILIZATION
See the treatments

RUBBER PLANTING DISTANCE
Standard: 550 trees/ha: 3 x 6 meters.

RUBBER WEEDING :

6 weedings a year, every 2 months, on a regular basis. Local observation and presence of Mikania or alang[2] may change that pattern.

INTERCROPPING
No intercropping

ASSOCIATED *TREES*

No associated trees.

FIELD SIZE per farm
PLOT SIZE : 500 m²
NUMBER OF PLOTS PER REPLICATION : 4 plots
NUMBER OF REPLICATION/farm : 2
OTAL NUMBER OF PLOT PER FARM : 8 plots
NUMBER of FAMS : 1
REPLICATION/FARM SIZE : 4 plots : 4 000 m²

DATA TO BE COLLECTED

Standard data for all RAS 1

RUBBER

- rubber growth measurements : diameter, height and whorls the first year every 3 months. Then girth the second year every 3 months. Sample of 30 trees per plot (according to field maps).
- Farmer's labour for each plot.
- Soil samples per replication on 0-15 and 15-30 cm.

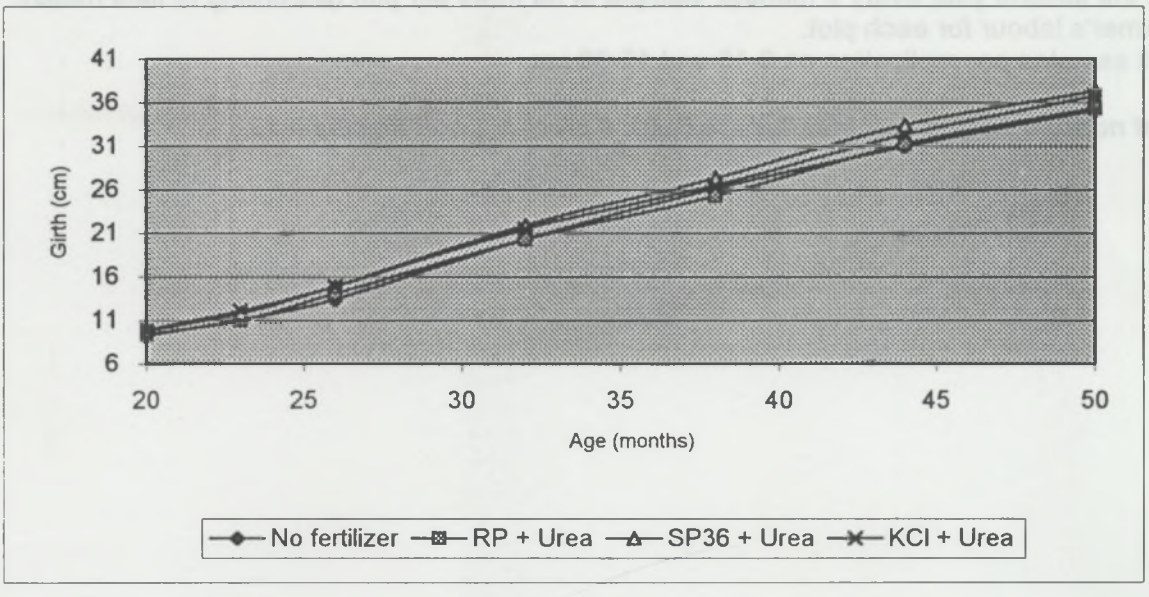
Total number of soil samples for the field: 8 plots x 2 soil depths = 16

RAS 13 - JAMBI
Effect of fertilizer application on rubber girth

Planting date: October 1996 - Mawi Lutan - Rantau Pandan

Replication	Fertilizer Applications	Girth (cm)						
		Jun-98	Sep-98	Dec-98	Jun-99	Dec-99	Jun-00	Dec-00
Replication 1	No fertilizer	10.7	12.8	15.0	22.4	28.6	32.6	36.2
	RP + Urea	10.2	11.8	15.3	22.2	27.8	34.0	38.1
	SP36 + Urea	10.0	11.6	14.5	21.1	26.5	32.8	37.1
	KCl + Urea	9.4	11.4	14.2	20.5	25.6	31.3	35.9
Replication 2	No fertilizer	7.7	9.3	11.9	18.2	23.7	29.2	34.1
	RP + Urea	8.6	10.2	12.8	18.3	22.7	28.4	32.6
	SP36 + Urea	9.6	12.0	15.3	22.6	28.2	34.0	37.5
	KCl + Urea	10.5	12.8	15.7	22.3	27.5	33.3	37.5
Average	**No fertilizer**	**9.2**	**11.1**	**13.4**	**20.3**	**26.2**	**30.9**	**35.1**
	RP + Urea	**9.4**	**11.0**	**14.1**	**20.3**	**25.2**	**31.2**	**35.3**
	SP36 + Urea	**9.8**	**11.8**	**14.9**	**21.9**	**27.3**	**33.4**	**37.3**
	KCl + Urea	**9.9**	**12.1**	**14.9**	**21.4**	**26.5**	**32.3**	**36.7**

Effect of fertilizer on rubber growth



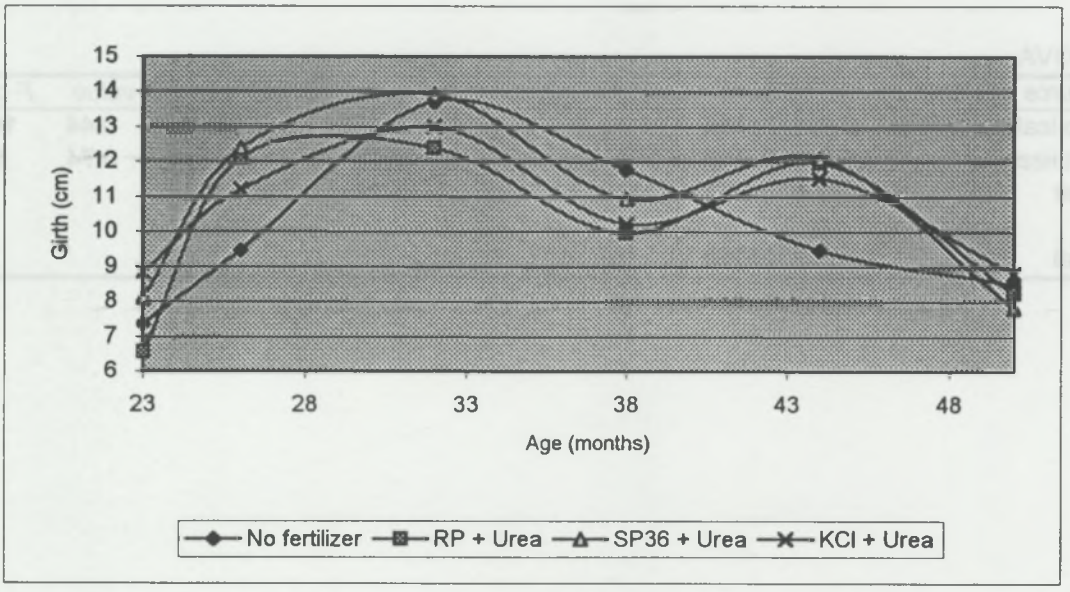
RAS 13 - JAMBI
Effect of fertilizer application on annual girth increment of rubber

Planting date: October 1996 - Mawi Lutan - Rantau Pandan

Replication	Fertilizer Applications	Annual girth increment (cm)					
		Sep-98	Dec-98	Jun-99	Dec-99	Jun-00	Dec-00
Replication 1	No fertilizer	8.29	8.72	14.91	12.40	7.94	7.26
	RP + Urea	6.58	14.06	13.69	11.22	12.50	8.09
	SP36 + Urea	6.41	11.61	13.24	10.76	12.58	8.58
	KCl + Urea	8.22	10.99	12.70	10.18	11.47	9.09
Replication 2	No fertilizer	6.43	10.21	12.52	11.12	11.02	9.73
	RP + Urea	6.52	10.17	11.09	8.70	11.44	8.38
	SP36 + Urea	9.76	13.17	14.61	11.11	11.61	7.06
	KCl + Urea	9.48	11.41	13.29	10.29	11.59	8.53

Average	**No fertilizer**	**7.4**	**9.5**	**13.7**	**11.8**	**9.5**	**8.5**
	RP + Urea	**6.6**	**12.1**	**12.4**	**10.0**	**12.0**	**8.2**
	SP36 + Urea	**8.1**	**12.4**	**13.9**	**10.9**	**12.1**	**7.8**
	KCl + Urea	**8.8**	**11.2**	**13.0**	**10.2**	**11.5**	**8.8**

Effect of fertilizer on annual girth increment



RAS 13- JAMBI
Rubber girth at 50 months

Planting date: October 1996 - Mawi Lutan - Rantau Pandan

Replication	No fertilizer	RP + Urea	SP36 + Urea	KCl + Urea
Rep 1	36.2	38.1	37.1	35.9
Rep 2	34.1	32.6	37.5	37.5

Anova: Two-Factor

SUMMARY	*Count*	*Sum*	*Average*	*Variance*
Rep 1	4	147.27	36.82	0.98
Rep 2	4	141.71	35.43	6.20
No fertilizer	2	70.30	35.15	2.26
RP + Urea	2	70.68	35.34	15.14
SP36 + Urea	2	74.60	37.30	0.09
KCl + Urea	2	73.41	36.70	1.36

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Replication	3.865174814	1	3.87	0.77	0.44	10.13
Fertilizer	6.568912369	3	2.19	0.44	0.74	9.28
Error	14.9832655	3	4.99			
Total	25.41735268	7				

JAMBI - RAS 1.3

1. Trial implementation

The trial studies different fertilizer combinations to determine the adequate needs for inputs in rubber agroforestry systems. Fertility level can varies for one location to another however, severe nutrient deficiencies affect rubber growth. The trial was implemented in a single farm with 2 replications in order to reduce variations due to factors like weeding or previous crops.

2. General observations on trial

Rubber growth was satisfactory in all treatments but best in the first replication. Plots without fertilizer obtained a slow growth during the first two years then maintained an annual increment comparable with fertilized plots. This observation confirms the needs for fertilization during the first two years but not after. The good fertility of Jambi soils permitted a normal growth in unfertilized plots.

3. Treatment analysis

The trial compares 3 fertilizer treatments and a control without fertilizer.

Girth at 50 months

Treatments	Girth in cm (%)
No fertilizer	35.2 (100)
RP + Urea	35.3 (101)
SP 36 + Urea	37.3 (106)
KCl + Urea	36.7 (104)

Statistic analysis indicates no significant differences between treatments. The association SP36 + urea gave the best results indicating that soluble phosphorus fertilizers help rubber growth in early stages.

4. Conclusion

Rubber clones performs well under RAS 1 conditions, which are close to secondary forest environment. Limited fertilization can help rubber growth but in Jambi soils, fertilization did not improve rubber growth significantly. Piedmont soils in Jambi are rather fertile and can support the normal development of rubber trees if previous vegetation was jungle rubber.

JAMBI - RAS 2.2
Rubber+ associated trees + intercropping /Palawija/rice

TITLE :
Clonal rubber in agroforestry environment: rubber + selected associated trees (92 trees/ha) + intercropping (rice or palawijas)

OBJECTIVE/HYPOTHESE
Objectives

As in jungle rubber system where rubber seedlings are associated with various kind of trees and plants, RAS 2.2 aims to associate useful trees (fruits and timber trees) with rubber, at a limited planting density, without substantial decrease in rubber yield.
Rubber is planted at normal planting density of 550/ha as associated trees are planted at 92 trees/ha with a maximum number of 30 for big trees (Durian and timber trees).

Hypotheses

It is expected that rubber growth during immature period will not be affected by associated trees competition as these selected fruits and timber trees have generally a slow growth pattern (in particular for durian, local fruits and timber species).
It is expected that intercropping during the first 3 or 4 years of rubber imature period will create a favorable environment for a good rubber growth due to intercrop weedings and secondary effect of fertilization..
Intercropping will limit the extend of weeds such as Imperata.

EXPECTED OUTPUTS

To produce recommendations on components of RAS 2.2 with rice or palawija intercroping:
weed management required for successful growth of rubber clone in this environment : 6 weedings per year seem to be sufficient to ensure rubber growth in Jambi : weeding is not a treatment in RAS 2.2 but a confirmation of the target of 6 weeding/year .
most suitable rice varieties and adapted amount of fertilization.
the effect of palawijas intercropping on rubber growth and the most adapted palawijas.

LOCATION : Jambi province, Kabupaten Muara Tebo, Kecematan Rantau Pandan, villages of Sepunggur (6 rep) and Muara Buat (1 rep)

YEAR : planting of rubber : December 1995-February 1996

DURATION: 5 to 6 years for immature period. The first 2 years are critical in terms of growth and survivability. Then, if possible, a minimum of 3 years of production monitoring.

MATERIALS AND METHOD

Note / the design of this trial has been modified in August 1996

Treatments

plot	Rep	Associated trees	intercrops	farmer's field	field's plot	clone
1	1	no	alang²/control	adnan1	all field	GT1
2	2	no	alang²/control	adnan1	all field	PB 260
3	1	no	palawija1/rice/ dose 0	Saer	A	GT1
4	2	no	rice/dose 0	Alias	A	GT 1
5	1	no	palawija1	Sabri	A	GT1
6	1	no	no palawija/control 2	Sabran	A	GT1
7	1	no	palawija2	Joni	A	GT 1
8	1	yes	no palawija/control 2	Sabran	B	GT1
9	1	yes	palawija1	Saer	B	GT1
10	2	yes	palawija1	Saer	C	GT1
11	3	yes	Palawija1	Sabri	B	GT1
12	1	yes	rice/dose BPS	Alias	B	GT1
13	1	yes	rice/dose CIFC	Alias	C	GT 1
14	1	yes	palawija2	Joni	A	GT 1

EXPERIMENTAL DESIGN

SUMMARY : 1 treatment : effect on various type of intercropping (with 7 levels) on rubber growth :

1. Control1 : alang² — 2 rep (Adnan1 & 2, plots A)
2 Control2 : no alang², no palawija — 2 rep (Sabran, A & B
3. Rubber + rice/dose 0 : — 2 rep (Alias A/Saer A)
4. Rubber + rice/dose BPS : — 1 rep (Alias B)
5. Rubber + rice/dose CRIFC : — 1 rep (Alias C)
6 Rubber + Palawij1 — 4 rep (Sabri A, Saer B&C, Sabri B)
7 Rubber + palawija2 — 2 rep (Joni A and B)

Randomized block system.
The first 2 years: Associated trees are not a significant treatment as trees are obviously too small to have an impact..
Weeding: 6 weedings/ year on the row. (100 cm on either side of the trees).

Rice experiment statistical analysis will be processed separately. In that case, rice with or without fertilization is just a "system", a level in the treatment 'intercropping'.

RUBBER

All replications are planted with GT1 except one with PB 260 (due to a problem of plant availability in Adnan's plot). Clone is not considered as a treatment.

FERTILIZATION

TCSDP fertilization program for UREA only for the first 2 years. No fertilization later.
SimplifiedTCSDP based fertilization program for JAMBI is the following:

In g/tree

	Planting time October 96	+ 3 months January 97	+ 6 months April	+ 9 months July	+ 12 months October
RP	200 or 115 grams SP 36				
Urea		50	50	50	50
SP36		0	0	0	0
KCl		0	0	0	0

Rubber planting distance

Standard : 550 trees/ha : 3 x 6 meters.
rubber weeding : 6 weedings a year , every 2 months, on a regular basis.

INTERCROPPING

See the levels.
Palawija are not fertilized.
Rice fertilization is the following:
Dose 0
Dose BPS
Dose CRIFC

ASSOCIATED TREES

Planting density: 92 trees/ha : 9 x 12 meters.
Case 2: : Durian + duku + other trees

No fertilization.
Weeding : same as for rubber (6 weedings/year).

FIELD SIZE
PLOT SIZE for rubber + intercropping: 1000 m²
PLOT SIZE for rubber + associated trees + intercropping: 1500/2000 m²
NUMBER OF REPLICATION: see the table
REPLICATION/FARM SIZE: 2 500/3000 m²
TOTAL SIZE OF THE TRIAL: 2 ha

DATA TO BE COLLECTED

Standard data for all RAS 2.2:
RUBBER
- Rubber growth measurements: diameter, height and whorls the first year every 3 months. Then girth the second year every 3 months. Sample of 30 trees per plot.

- Farmer's labor for each plot.
- soil samples per replication on 0-10 and 10-20 cm.

ASSOCIATED TREES

- tree growth measurements : girth every year at planting anniversary time for all trees per plot.

RICE

date of planting
date of harvest
yield per plot at 14 % water content

PALAWIJA

distribution of crops and average planting density
date of planting for each crop
date of harvest for each crop
yields for banana and cassava.
distribution between self-consumption and sales
Labor requirements per plot.

RICE EXPERIMENT in RAS 2.2

In Alias and Saer plot A fields:

Rice variety: SAIM (from Sembawa)
Treatment : on fertilization : 3 levels
dose 0
dose BPS
dose CRIFC

"BPS fertilization dose" is the economic dose recommended by BPS/Sembawa for JAMBI.
FERTILIZATION DOSE

DOSE IN KG/HA	UREA	SP 36	KCL
BPS	100	160	75

"CRIFC fertilization dose" is the dose recommended by CRIFC/Bogor for JAMBI.
FERTILIZATION DOSE

DOSE IN KG/HA	UREA	SP 36	KCL
CRIFC	150	220	150

Urea is supplied in 3 times: 1/3 at planting time, 1/3 1 month after planting and 1/3 2 months after planting.

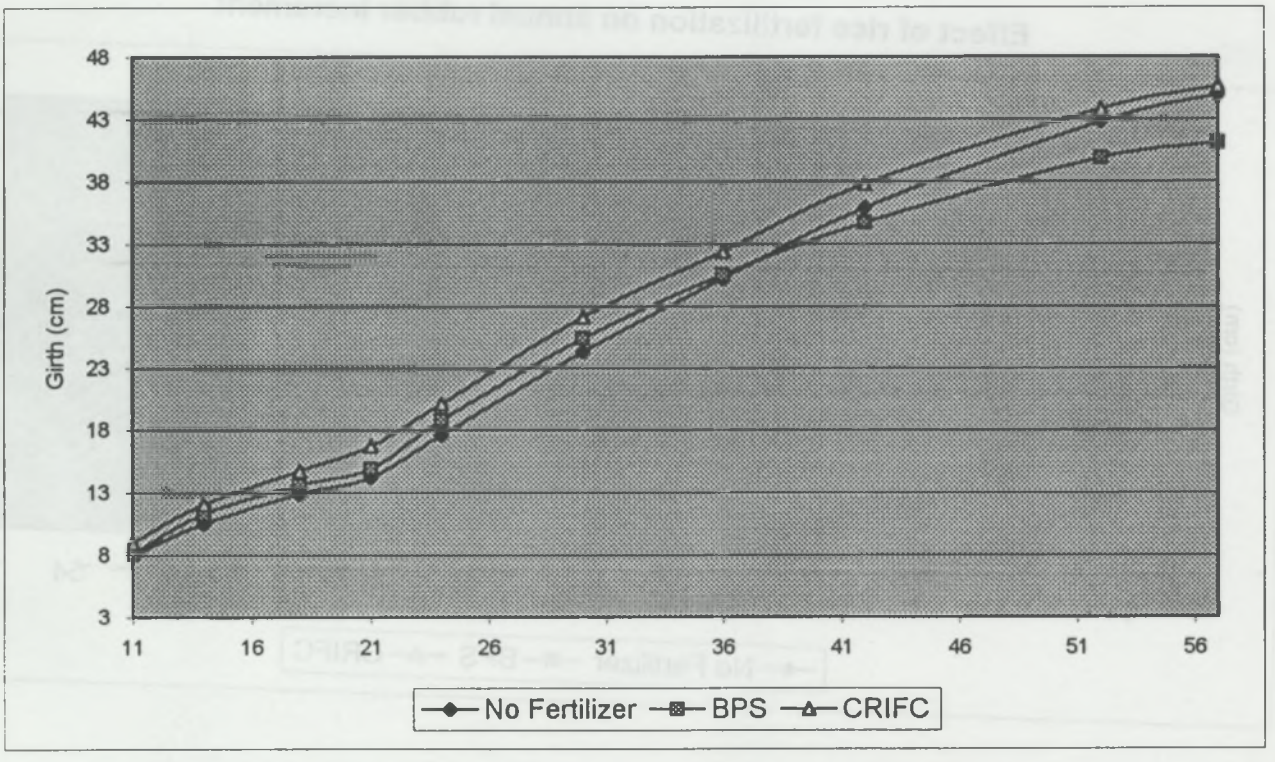
RAS 22 - JAMBI
Effect of food crops and fruit trees on rubber girth

Planting date: February 1996 - Sepungur

1. Residual effect of rice fertilization

Farmer		Rice Fertilization	Girth (cm)									
			Jan-97	Apr-97	Aug-97	Nov-97	Feb-98	Aug-98	Feb-99	Aug-99	Jun-00	Nov-00
Alisri	A	No Fertilizer	7.8	9.4	11.7	12.9	16.2	22.8	29.2	34.8	42.2	45.2
	B	BPS	8.5	11.7	14.3	15.5	19.4	27.3	33.5	38.2	44.5	45.5
	C	CRIFC	9.0	11.9	14.7	17.3	20.5	27.9	33.6	38.5	44.6	46.4
Saer	A	No Fertilizer	8.1	11.7	14.2	15.6	19.0	25.8	31.2	37.0	43.4	44.7
	B	BPS	7.7	10.9	13.0	14.3	18.2	23.5	27.6	31.2	35.2	36.7
	C	CRIFC	9.0	12.3	14.8	16.2	19.7	26.3	31.1	37.1	43.0	44.8
Average	**A**	**No Fertilizer**	**7.9**	**10.5**	**12.9**	**14.3**	**17.6**	**24.3**	**30.2**	**35.9**	**42.8**	**44.9**
	B	**BPS**	**8.1**	**11.3**	**13.6**	**14.9**	**18.8**	**25.4**	**30.5**	**34.7**	**39.8**	**41.1**
	C	**CRIFC**	**9.0**	**12.1**	**14.8**	**16.7**	**20.1**	**27.1**	**32.3**	**37.8**	**43.8**	**45.6**

Effect of rice fertilization on rubber growth



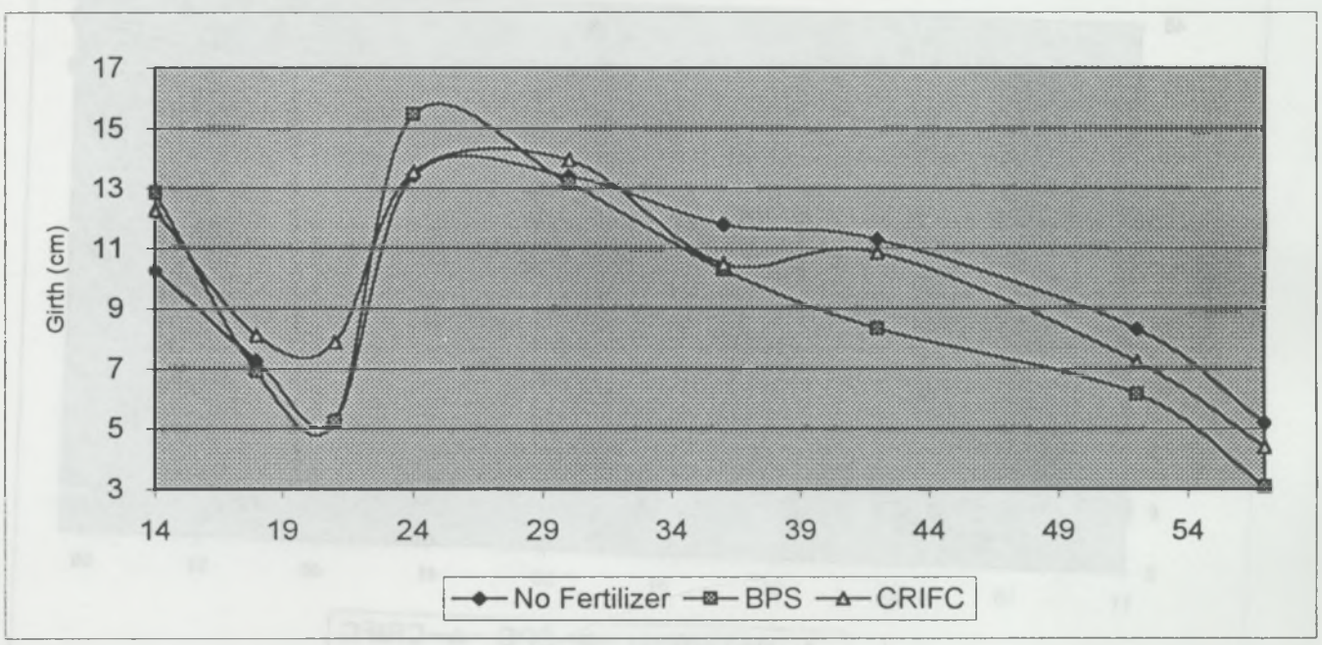
RAS 22 - JAMBI
Effect of food crops and fruit trees on annual rubber increment

Planting date: February 1996 - Sepungur

1. Residual effect of rice fertilization

Farmer		Rice Fertilization	Girth (cm)								
			Jan-97	Apr-97	Aug-97	Nov-97	Feb-98	Aug-98	Feb-99	Aug-99	Jun-00	Nov-00
Alisri	A	No Fertilizer		6.1	7.1	4.9	13.2	13.2	12.8	11.1	8.9	7.2
	B	BPS		13.0	7.7	5.0	15.5	15.7	12.5	9.4	7.6	2.4
	C	CRIFC		11.6	8.5	10.4	12.8	14.8	11.4	9.8	7.3	4.3
Saer	A	No Fertilizer		14.4	7.5	5.6	13.7	13.6	10.8	11.5	7.7	3.2
	B	BPS		12.7	6.1	5.5	15.5	10.6	8.1	7.3	4.8	3.7
	C	CRIFC		12.9	7.7	5.3	14.3	13.1	9.5	12.0	7.1	4.5
Average	**A**	**No Fertilizer**		**10.3**	**7.3**	**5.3**	**13.4**	**13.4**	**11.8**	**11.3**	**8.3**	**5.2**
	B	**BPS**		**12.9**	**6.9**	**5.2**	**15.5**	**13.2**	**10.3**	**8.3**	**6.2**	**3.1**
	C	**CRIFC**		**12.3**	**8.1**	**7.9**	**13.6**	**14.0**	**10.5**	**10.9**	**7.2**	**4.4**

Effect of rice fertilization on annual rubber increment



JAMBI - RAS 2.2

1. Trial implementation

The trial studies different fertilization on rice in order to increase production and possibly reduce weeding requirement in the farm. Fertilizer schemes were based on recommendations of BPS (Rubber Institute Sembawa) and CRIFC (Research Center for Food Crops). The trial shows that performances on food crops are highly variable due to pest incidence (insects and birds) and, upland rice cultivation is a risky activity for farmers.

2. General observations on trial

Rubber growth is satisfactory in all treatments and rubber benefited from intensive weeding conducted on rice field. The principal effect is the control of grasses, which is beneficial to rubber. Fertilized and unfertilized plots are not different for rubber growth mainly because fertilization was applied on the rubber inter-row and far from rubber trees.

3. Treatment analysis

The trial compares 2 fertilizer treatments and a control without fertilizer.

Rubber girth after 57 months:

Treatments	Girth in cm (%)
No fertilizer on rice	44.9 (100)
BPS dose on upland rice	41.1 (92)
CRIFC dose on upland rice	45.6 (102)

CRIFC dose obtained best rubber growth but the difference with other treatments is not significant. Plots with BPS fertilization had slower growth than other plots in year 2000.

4. Conclusion

RAS 2 system allows rice cultivation between rubber row. This is a common practice by farmers but in slash and burn system, upland is cultivated prior rubber cultivation. Rice intercropping doesn't affect rubber growth and, rubber benefits from weeding done on rice. Planting some fruit trees in the inter-row helps to reduce weeding needs after annual crops are no cultivated anymore.

JAMBI - RAS 2.5
RUBBER + CINNAMON

TITLE : Clonal rubber in agroforestry environment : RUBBER + CINNAMON

OBJECTIVE/HYPOTHESE
Objectives

Cinnamon is a current good crop opportunity for farmers in hilly areas, in the piedmont of the Barisan mountains, Central Sumatra. Cinnamon is generally cut and harvested at 7-8 years old and required a limited shading. The association of rubber and cinnamon valorize the immature period of rubber, which profit from weeding of cinnamon.
(Rubber is planted at normal planting density of 550 trees/ha . Cinnamon is planted at 3 x 3 meters, 1111 trees per ha).

Hypotheses
- It is expected that rubber growth during immature period will not be affected by cinnamon.
- It is expected that cinnamon intercropping and its consequent weeding during rubber immature period will profit to rubber growth.
- Cinnamon should profit from the shading of young rubber trees.
- The total shading will limit extension of Imperata in the plot.

EXPECTED OUTPUTS

To produce recommendations on components of RAS 2.5:
- the effect of cinnamon on rubber growth.
- the comparison between association and monoculture of each rubber and cinnamon.

LOCATION: Jambi province, Kabupaten Muara Tebo, Kecematan Rantau Pandan,

TRIAL 1 village of Muara Buat (3 rep)
TRIAL 2 SMP Muara Bungo (3 rep)

YEAR:
planting of rubber :
TRIAL 1 /December 1995-February 1996
TRIAL 2/October 1996

DURATION
5 to 6 years for immature period. The first 2 years are critical in terms of growth and survivability. Then, if possible, a minimum of 3 years of rubber production monitoring. Cinnamon will be harvested the year 7 or 8.

MATERIALS AND METHOD
Treatments

1. Control: rubber in monoculture, rubber is cropped as in RAS 1: Weeding on the row. Interrow is occupied by secondary forest regrowth.

2. Rubber + cinnamon: 6 complete weedings/ year.

3. Cinnamon in monoculture

EXPERIMENTAL DESIGN
Randomized block system: 3 rep/trial.

RUBBER

TRIAL 1 / All rep are planted with GT1. 1995
TRIAL 2 / All rep are planted with PB 260. 1996

FERTILIZATION
Simplified TCSDP fertilization program: 115 grams/tree of SP 36 at planting and 50 grams/tree UREA every 3 months only for the first 2 years. No fertilization later.

Simplified TCSDP based fertilization program for JAMBI is the following:
In g/tree

	Planting time October 96	+ 3 months January 97	+ 6 months April	+ 9 months July	+ 12 months October
RP	200 or 115 grams SP 36				
Urea		50	50	50	50
SP36		0	0	0	0
KCl		0	0	0	0

RUBBER PLANTING DISTANCE
Standard : 550 trees/ha : 3 x 6 meters.

RUBBER WEEDING :
6 weeding a year, every 2 months, on a regular basis, on the row for Rubber monoculture and complete for cinnamon and rubber + cinnamon.

CINNAMON

Planting density : 1111 trees/ha :3 x 3 meters.
No fertilization.
Weeding : same as for rubber monoculture (6 complete weeding/year).

FIELD SIZE

PLOT SIZE for rubber + intercropping: 1000 m²/1500 m²
NUMBER OF PLOTS PER REPLICATION: 3 plots
REPLICATION/FARM SIZE: 3000 m²/4500 m²
NUMBER OF REPLICATION = 3
TOTAL SIZE OF THE TRIAL: 0,9 ha/1.35 ha

DATA TO BE COLLECTED
Standard data for all RAS 2.5:

RUBBER
- rubber growth measurements : diameter, height and whorls the first year every 3 months. Then girth the second year every 3 months. Sample of 30 trees per plot.
- Farmer's labour for each plot.
- soil samples per replication on 0-10 and 10-20 cm.

CINNAMON

- tree growth measurements : girth 6 months after planting for a a sample of 30 trees per plot.
- Labor requirements per plot.

RICE EXPERIMENT in RAS 2.5, in 1996/97 at SMPT

2 TREATMENTS / RICE VARIETY X RICE FERTILIZATION

TREATMENT 1 : rice variety
Variety 1 : SAIM (from Sembawa)
Variety 2 : improved variety (Way Rarem or Jatiluhur)

TREATMENT 2: rice fertilization
Treatment: on fertilization : 3 levels
- dose 0
- dose BPS
- dose CRIFC

"BPS fertilization dose" is the economic dose recommended by BPS/Sembawa for JAMBI.

FERTILIZATION DOSE

Dose in kg/ha	Urea	SP 36	KCl
BPS	100	160	75

"CRIFC fertilization dose" is the dose recommended by CRIFC/Bogor for JAMBI.

FERTILIZATION DOSE

Dose in kg/ha	Urea	SP 36	KCl
CRIFC	150	220	150

The rice trial is established on RAS 2.5 for the year of planting only.

DESIGN

REP 1	REP 2	REP 3
RUBBER ONLY SAIM DOSE 0	RUBBER +CINNAMON SAIM DOSE BPS	CINNAMON ONLY WAYARAREM DOSE CRIFC
CINNAMON ONLY SAIM DOSE CRIFC	RUBBER +CINNAMON WAYARAREM DOSE BPS	RUBBER ONLY *no rice*
RUBBER +CINNAMON *no rice*	RUBBER ONLY WAYARAREM DOSE 0	CINNAMON ONLY *no rice*

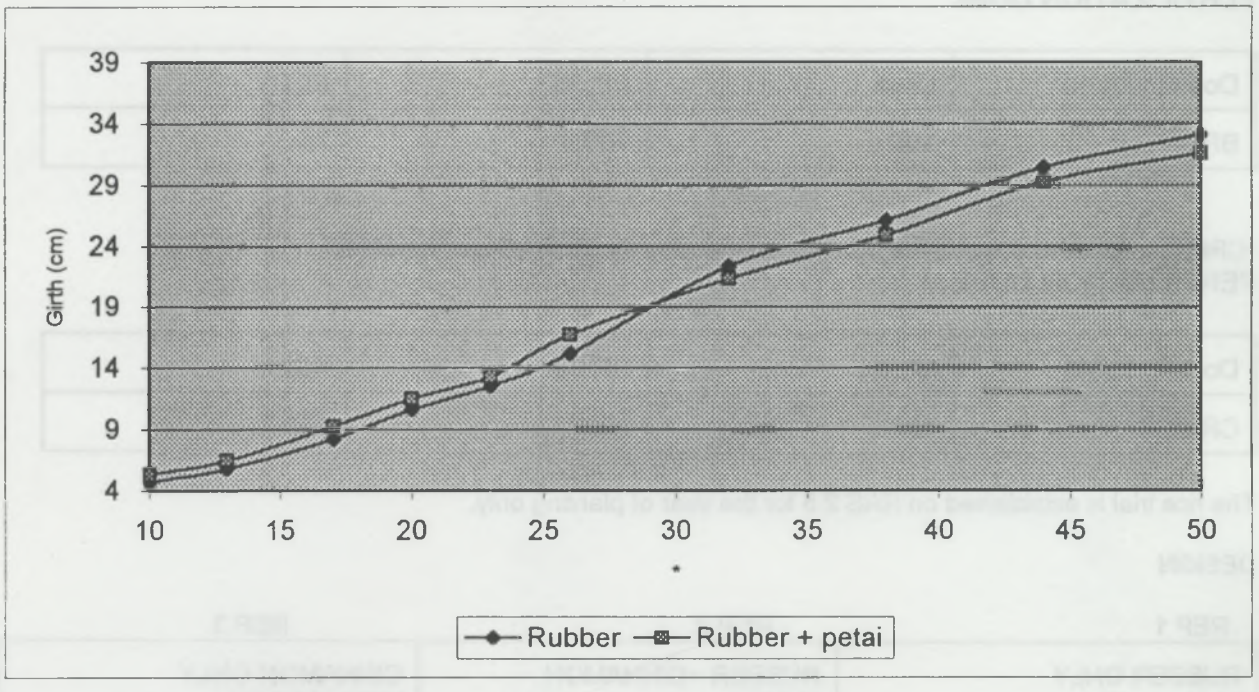
Randomized block system: 2 replications

RAS 25 - JAMBI
Effect of associated trees on rubber girth

Planting date: October 1996 - SMTP

Replication	Associated Trees	Girth (cm)									
		Aug-97	Nov-97	Mar-98	Jun-98	Sep-98	Dec-98	Jun-99	Dec-99	Jun-00	Dec-00
Rep 1	Rubber	5.0	6.4	8.9	11.2	13.5	16.1	22.1	25.9	29.5	31.9
	Rub + petai	4.3	5.2	7.5	9.2	10.3	14.3	17.5	20.6	25.3	28.5
Re 2	Rubber	4.0	4.6	6.1	8.6	10.1	12.5	23.5	27.6	32.8	36.0
	Rub + petai	4.7	5.9	8.5	11.1	12.9	15.8	19.7	22.8	26.8	29.2
Rep 3	Rubber	5.1	6.3	9.7	12.0	13.9	17.0	21.6	24.8	29.1	31.5
	Rub + petai	6.9	8.4	11.7	14.2	16.5	20.0	26.6	31.2	35.7	37.2
Average	**Rubber**	**4.7**	**5.8**	**8.2**	**10.6**	**12.5**	**15.2**	**22.4**	**26.1**	**30.5**	**33.1**
	Rub + petai	**5.3**	**6.5**	**9.3**	**11.5**	**13.3**	**16.7**	**21.3**	**24.9**	**29.3**	**31.6**

Effect of weeding on rubber growth

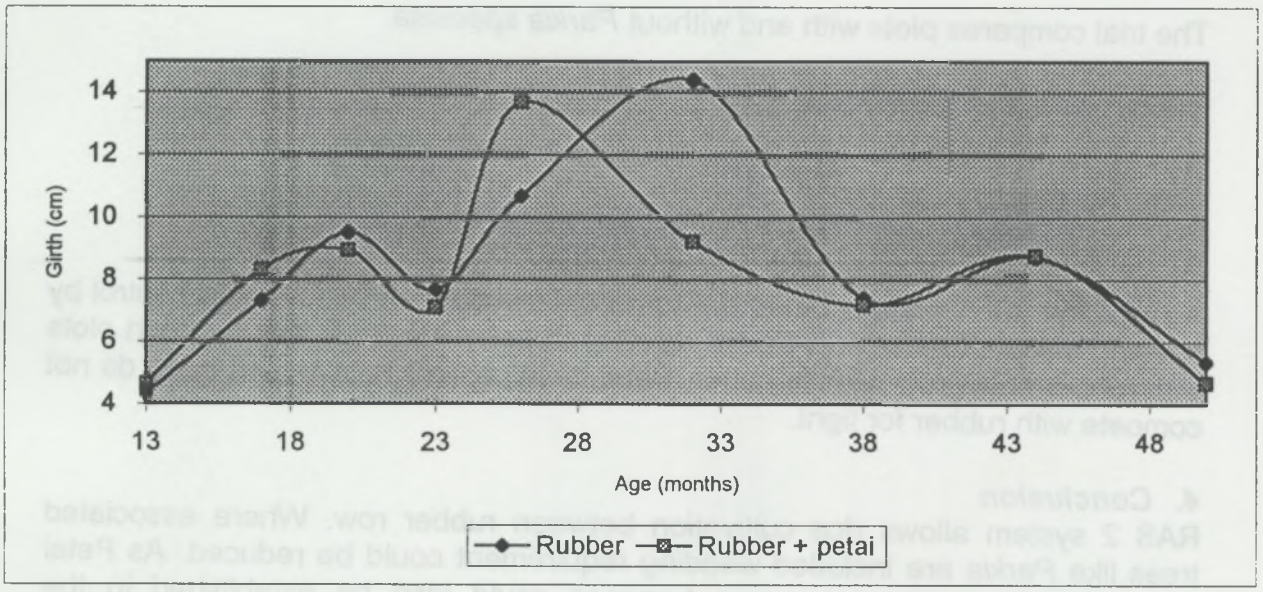


RAS 25 - JAMBI
Effect of associated trees
on annual girth increment of rubber

Planting date: October 1996 - SMTP

Replication	Associated Trees	Annual girth increment (cm)								
		Aug-97	Nov-97	Mar-98	Jun-98	Sep-98	Dec-98	Jun-99	Dec-99	Jun-00	Dec-00
Rep 1	Rubber		5.7	7.5	9.2	9.3	10.1	12.1	7.5	7.2	4.9
	Rub + petai		3.5	6.8	6.7	4.7	15.9	6.5	6.2	9.3	6.4
Re 2	Rubber		2.5	4.3	10.3	6.0	9.4	22.0	8.3	10.4	6.2
	Rub + petai		4.6	8.0	10.1	7.5	11.4	7.9	6.1	8.1	4.7
Rep 3	Rubber		4.8	10.2	9.0	7.7	12.5	9.1	6.4	8.5	4.9
	Rub + petai		5.8	10.1	10.0	9.1	13.8	13.3	9.2	8.9	2.9
Average	**Rubber**		**4.3**	**7.3**	**9.5**	**7.7**	**10.7**	**14.4**	**7.4**	**8.7**	**5.4**
	Rub + petai		**4.6**	**8.3**	**8.9**	**7.1**	**13.7**	**9.2**	**7.2**	**8.8**	**4.7**

Effect of associated trees on annual girth



JAMBI - RAS 2.5

1. Trial implementation

The trial studies tree association with Petai *Parkia speciosa* planted between rubber row. Petai is a legume tree, which produces edible seeds. In experiment conditions *Parkia* grows very slowly in early stages and it didn't compete with rubber for light.

2. General observations on trial

Rubber growth was satisfactory in all plots it was slightly better with Parkia because of weed control in the inter-row.

3. Treatment analysis

The trial compares plots with and without *Parkia speciosa*.

Rubber girth after 50 months

Treatments	Girth in cm (%)
Rubber alone	33.1 (100)
Rubber associated with *Parkia speciosa* (Petai)	31.6 (95)

Association with *Parkia* is beneficial to rubber because of better weed control by shading effect. Rubber with *Parkia* developed better up to 36 months then plots with rubber only grow slightly better. Petai development is slow and trees do not compete with rubber for light.

4. Conclusion

RAS 2 system allows rice cultivation between rubber row. Where associated trees like *Parkia* are included weeding requirement could be reduced. As Petai has a slow development, some bananas could also be established in the interrow.

RAS TRIALS IN WEST KALIMANTAN

WEST KALIMANTAN/ RAS 1.1 /Weeding

TITLE :
Clonal rubber in agroforestry environment: genotype x environment interaction.

OBJECTIVE/HYPOTHESE
Objectives

- To investigate the growth of an improved rubber clone (PB 260 or another clone) in close to jungle rubber conditions, under various intensities of weeding, with emphasis on the critical first 2 years of establishment.

- To compare growth of this clone under currently prescribed standard (theoretically optimal) plantation management conditions (TCSDP technological package), with its growth under three variants of close to jungle rubber management (differing by increasing intensity of weeding on the rubber row). Secondary forest is allowed to grow in the inter-row.

Hypotheses

Main Hypothesis

- Increasing intensity of weeding within the rubber row (compared to that of unselected seedlings) will result in greater growth of rubber due to a decrease in intensity of below-ground competition from regenerating secondary forest species, taking into account the fact that clones required more weeding than unselected seedlings (Note: clones have never been tested in close to jungle rubber conditions).

Secondary Hypotheses

1. Increased intensity of weeding only within the row will not affect the regenerative capacity of the useful secondary forest species (e.g: fruits and timber trees, rattan....). E.g. constant disturbance will not preclude the establishment of useful secondary forest species due to e.g. dominance of grasses (or ferns). Theoretically this disturbance should not be too detrimental to soil fertility, if slash is left as mulch. Soil is still protected
2. Increased intensity of weeding only within the row will not affect the susceptibility to invasion by Imperata, except on the row.
3. Secondary forest regrowth in the inter-row may not be more competitive than a leguminous cover crop used in the inter-row in terms of rubber growth.
4. Classical LCC used for rubber are viny species and required more weeding than natural forest regrowth.

EXPECTED OUTPUTS

- To produce recommendations on the minimum amount of weed management required for successful growth of this rubber clone in smallholder (jungle rubber) conditions for a minimum level of other inputs (use of polybagged clonal planting material and fertilization the first 2 years).

LOCATION : West-Kalimantan province, Kabupaten Sanggau, Kecematan Sanggau Kapuas, villages of Kopar and Engkayu (Group I = 5 rep/95 and group II : 6 rep/96) and Embaong (October 1996) : total 6 replications for 1995 and 6 rep for 1996/february + 6 rep in 1996/october. Number of trial per year of planting : 1 in 1995 and 2 in 1996.

YEAR :
TRIAL 1:
Rubber planting: January 1995 (direct planting) and April (tapih technique, similar to polybags)
Planting density 550 trees/ha : normal density : 4 rep : code file : 1a_1195n or code C
Planting density 750 trees/ha : high density : 2 rep : code file : 1a_1195h or code B

TRIAL 2 :
Rubber planting: January 1996

Planting density 550 trees/ha: normal density: 3 rep : code file : 1a_1196j or code E
Planting density 750 trees/ha: high density: 2 rep : code file : 1a_1196h or code D

TRIAL 3:
Planting of rubber : October/December 1996
Planting density 550 trees/ha: normal density : 5 rep : code file : 1a_1196 or code A

Original trial design (trial 1 and 2)

Planting density	Number of plots per rep	number of rep	date of planting
550/Ha	3	3	1995 (old design)
550/Ha	4	3	1996 (new design)
750/Ha	3	2	1995 (old design)
750/Ha	3	3	1996 (old design)

New design trial (October 1996) trial 3

Planting density	Number of plots per rep	number of rep	date of planting
550/Ha	4	6	October 1996

The old design do not have a control with LCC (similar to that of monoculture): 3 plots per rep.
The new design has a control: 4 plots per rep.
The trials planted with normal density in 1996 are "new design).
The comparison, for the trial 2 established in 1996, between the 2 planting density 550 and 750 trees/ha is using only 3 plots per rep.

DURATION
5 to 6 years for immature period. The first 2 years are critical in terms of growth and survivability. Then, if possible, a minimum of 3 years of production monitoring.

MATERIALS AND METHOD

EXPERIMENTAL DESIGN

1) NEW DESIGN : 4 plots
Randomized block system : treatment on weeding level.

Treatments
1. Control**:** Prescribed standard plantation management conditions (TCSDP), using leguminous cover crop, weeding (100cm on either side of the trees). Weeding: **8 times a year, the first 2 years**
2. Regrowth of secondary forest in inter-row area, Low intensity of weeding in the rubber. Whole strip weeding, 100 cm on either side of trees, **4 times a year, the first 2 years**.
3. Regrowth of secondary forest in inter-row area, Medium intensity of weeding in the rubber row: Whole strip weeding, 100cm on either side of trees, **6 times a year, the first 2 years**
4. Regrowth of secondary forest in inter-row area, High intensity of weeding in the rubber row: Whole strip weeding, 100 cm on either side of trees**, 9 times a year, the first 2 years**

2 trials planted in February 1996 (3 rep) and October 1996 (6 rep)
The weeding program for the following years is the following :

FOR RAS 1.1 trials planted end of 1996
WEST KALIMANTAN

PLOT/year	1	2	3	4	5
A	4x	2x	2x	1x	1x
B	6x	4x	4X	3X	3X
C	8x	6x	6x	6x	6x
D + LCC	8x + LCC	6x + LCC	6x + LCC	6x + LCC	6x + LCC

The amount of labor and number of weeding is higher in West Kalimantan due to *Imperata cylindica*

2) OLD DESIGN : 3 plots/2 planting density
Clone is not a treatment.
Planted in January/April 1995 : 3 rep.

Treatments
Treament 1 on weeding level :
1. Regrowth of secondary forest in inter-row area, Low intensity of weeding in the rubber: Whole strip weeding, 100 cm on either side of trees, **4 times a year, the first 2 years**.
2. Regrowth of secondary forest in inter-row area, Medium intensity of weeding in the rubber row: Whole strip weeding, 100cm on either side of trees, **6 times a year, the first 2 years**
3. Regrowth of secondary forest in inter-row area, High intensity of weeding in the rubber row: Whole strip weeding, 100 cm on either side of trees, **8 times a year, the first 2 years**
(no TCSDP) control

FOR RAS 1.1 first trial planted early 1995
WEST KALIMANTAN

PLOT/year	1	2	3	4	5
A	0x	4x	4x	2x	1x
B	1x	6x	6x	4X	3X
C	3x	8x	8x	6x	6x

In this trial, the original protocol for the first year was "0x, 1x and 3x" weeding/year, rapidly abandoned to "4x, 6x, 8X"

FOR RAS 1.1 first trial planted early 1996
WEST KALIMANTAN

PLOT/year	1	2	3	4	5
A	4x	4x	2x	2x	1x
B	6x	6x	4x	4X	3X
C	8x	8x	6x	6x	6x
D + LCC	8x + LCC	6x + LCC	6x + LCC	6x + LCC	6x + LCC

The amount of labor and number of weeding is higher in West Kalimantan due to *Imperata cylindica*

Treatment 2 on planting density :
1 550 rubber trees/ha
2 750 rubber trees/ha

EXPERIMENTAL DESIGN : SUMMARY

TRIAL 1/January-April 1995 : old design (no TSDP control plot)
Split plot with main treatment on weeding level and second treatment on planting density (550/750). Clone is not a treatment.
This trial has been planted in 1995 with 4 rep/550 (including the rep originally as RAS 3/Timber) and 2 rep/750 (one failed).
In July 1996, one former RAS 3.2/timber field has been transformed into RAS 1/550/3 plots.
Located in Kopar/Engkayu I

TRIAL 2/February 1996 : new design with TCSDP control plot
Randomized block system with 1 treatment on weeding level.
3 rep of RAS 1/550/4 plots has been planted in February 1996.
3 rep/750 has been planted in 1996 (it was too late to cancel or modify these plots). Possibility of using the 3 plots of the new design RAS 1 trial plots also planted in 1996 for the same statistical analysis (split plot).
Located in Engkayu II

TRIAL 3/October 1996 : new design with TCSDP control plot
Randomized block system with 1 treatment on weeding level
6 rep of RAS 1/550/4 plots has been planted in October 1996.
Located in Embaong.

RUBBER
FERTILIZATION
TCSDP fertilization program (NPK) only for the first 2 years. No fertilization later.

In g/tree

	Planting time	+ 3 months	+ 6 months	+ 9 months	+ 12 months
CA (trial 3 only)	40	40	40	40	
Urea		50	50	50	50
SP36	540 (trial 3 only)	40	40	40	40
RP rock phosphate	200 (trial 1 and 2 only)				
KCL			25	25	25

IN KG/HA	planting time	+ 3 months	+ 6 months	+ 9 months	+ 12 months
CA in kg/ha	22	22	22	22	
Urea in kg/ha		28	28	28	28
SP36 kg/ha	300 (trial 3 only)	22	22	22	22
RP	110 (trial 1 and 2)				
KCl kg/ha			14	14	14

Rubber planting distance
Standard : 550 trees/ha : 3 x 6 meters.

INTERCROPPING
Local rice the first year with some palawijas such as corn and cassava.

INTER ROW DURING IMATURE PERIOD
The secondary forest (belukar) is allowed to grow at the conditions that trees and shrubs do not reach a height greater than that of rubber (selective cutting if necessary).

New design
PLOT SIZE: 1000 m
NUMBER OF PLOTS PER REPLICATION: 4 plots
REPLICATION/FARM SIZE : 4 000 m
NUMBER OF REPLICATION per trial = 3 AND 6
TOTAL SIZE OF TRIAL 1 : 1.2 ha, RIAL 2 : 2.4 ha

Old design
PLOT SIZE : 1000 m
NUMBER OF PLOTS PER REPLICATION : 6 plots
REPLICATION/FARM SIZE: 3 000 m
NUMBER OF REPLICATION per trial =
- 3 for 550 and 2 only for 750 for the 1995 trial.
- 3 for the 1996 trial (using plots from the new design).

TOTAL SIZE OF 1 TRIAL: 1.8 ha

DATA TO BE COLLECTED

Standard data for all RAS 1:
- rubber growth measurements : diameter, height and whorls the first year every 3 months. Then girth the second year every 3 months. Sample of 30 trees per plot (4 plots per rep).
- Farmer's labor for each plot.
- soil samples per replication on 0-5 and 5-20 cm.
- rice production.
- Labor requirement per plot.

FIELD DESIGN

Old design
PLOT SIZE: 1000 m
NUMBER OF PLOTS PER REPLICATION: 6 plots: rep are divided in 2 sub -rep with 2 farmers
REPLICATION/FARM SIZE: 3 000 m (rep of 550 or 750 trees/ha)
NUMBER OF REPLICATION per trial =
- 3 for 550 and 2 only for 750 for the 1995 trial.
- 3 for the 1996 trial (using plots from the new design for 550).

farmers A, B and C : planting density : 550 trees/ha

4 weeding/year	6 weeding/year	8 weeding/year

farmers D, E and F : planting density : 750 trees/ha

4 weeding/year	6 weeding/year	8 weeding/year

New design

PLOT SIZE: 1000 m

NUMBER OF PLOTS PER REPLICATION: 4 plots

REPLICATION/FARM SIZE: 4 000 m

NUMBER OF REPLICATION per trial = 3 (for trial n2/February 1996) AND 6 (for trial n3/ October 96)

planting density : 550 trees/ha only

Control LCC + 8 weeding/year	4 weeding/year	6 weeding/year	8 weeding/year

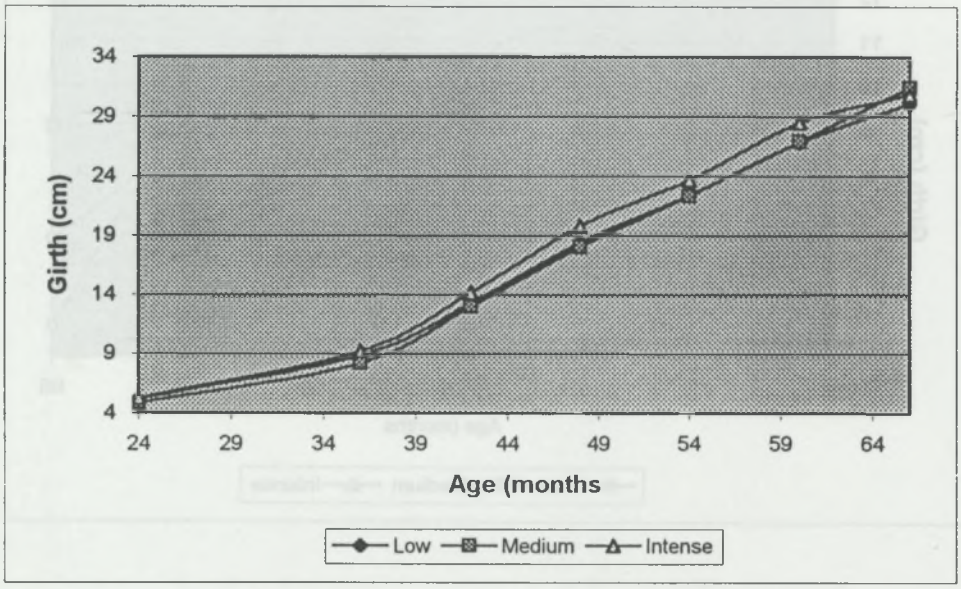
RAS 11a - WEST KALIMANTAN

Effect of weeding intensity on rubber girth

Planting date: February 1995 and February 1996 Kopar 1- Engkayu2

Farmer	Weeding Intensity	Girth (cm)						
		Feb-97	Feb-98	Aug-98	Feb-99	Aug-99	Feb-00	Aug-00
Fransisco	Low	3.6	4.4	8.9	13.4	17.6	21.7	25.8
	Medium	3.7	4.8	9.0	14.5	19.7	25.0	28.8
	Intense	3.8	5.2	9.9	15.4	20.1	25.6	29.7
Stepanus	Low	6.6	10.4	13.5	20.8	24.8	28.6	31.9
	Medium	6.5	13.8	18.8	25.0	29.1	32.5	35.9
	Intense	6.4	13.0	18.5	24.0	27.7	31.7	34.6
Jampi 2	Low	4.4	8.6	13.2	17.8	21.7	27.6	32.6
	Medium	4.2	5.7	10.0	14.3	17.0	21.5	25.4
	Intense	3.9	6.1	10.6	14.6	19.2	24.3	28.1
Sudin 1	Low	5.1	10.9	16.5	20.8	24.1	28.0	31.3
	Medium	5.9	10.0	15.3	19.9	23.7	28.2	32.1
	Intense	6.1	9.4	13.5	18.0	20.9	25.0	28.4
Apan	Low	4.9	10.2	15.6	20.8	24.8	30.4	32.6
	Medium	3.6	6.6	10.8	15.4	19.9	24.1	28.2
	Intense	6.0	12.1	17.2	24.8	27.5	31.8	33.6
Otol	Low	6.4	8.7	12.1	16.6	21.2	24.3	26.2
	Medium	5.1	8.3	14.0	19.0	24.4	29.9	32.7
	Intense	5.2	9.7	15.5	21.9	26.7	32.3	35.6
Average	**Low**	**5.2**	**8.9**	**13.3**	**18.4**	**22.4**	**26.8**	**30.1**
	Medium	**4.8**	**8.2**	**13.0**	**18.0**	**22.3**	**26.9**	**30.5**
	Intense	**5.2**	**9.3**	**14.2**	**19.8**	**23.7**	**28.5**	**31.7**

Effect of weeding on rubber growth



RAS 11a - WEST KALIMANTAN

Effect of weeding intensity on rubber girth increment

Planting date: February 1995 and February 1996 Kopar 1- Engkayu2

Farmer	Weeding Intensity	Annual girth increment (cm)						
		Feb-97	Feb-98	Aug-98	Feb-99	Aug-99	Feb-00	Aug-00
Fransisco	Low		0.8	9.0	9.0	8.4	8.3	8.1
	Medium		1.1	8.4	11.0	10.4	10.6	7.6
	Intense		1.4	9.4	11.0	9.4	11.0	8.1
Stepanus	Low		3.8	6.2	14.6	8.0	7.7	6.5
	Medium		7.3	10.0	12.4	8.2	6.8	6.7
	Intense		6.6	11.0	11.0	7.4	8.0	5.8
Jampi 2	Low		4.2	9.2	9.2	7.8	11.8	9.9
	Medium		1.5	8.6	8.6	5.4	9.0	7.8
	Intense		2.2	9.0	8.0	9.2	10.3	7.6
Sudin 1	Low		5.8	11.2	8.6	6.6	7.8	6.5
	Medium		4.1	10.6	9.2	7.6	9.0	7.8
	Intense		3.3	8.2	9.0	5.8	8.2	6.7
Apan	Low		5.3	10.8	10.4	8.0	11.1	4.6
	Medium		3.0	8.4	9.2	9.0	8.5	8.1
	Intense		6.1	10.2	15.2	5.4	8.7	3.5
Otol	Low		2.3	6.8	9.0	9.2	6.1	4.0
	Medium		3.2	11.4	10.0	10.8	11.0	5.6
	Intense		4.5	11.6	12.8	9.6	11.2	6.7
Average	**Low**		**3.7**	**8.9**	**10.1**	**8.0**	**8.8**	**6.6**
	Medium		**3.4**	**9.6**	**10.1**	**8.6**	**9.2**	**7.3**
	Intense		**4.0**	**9.9**	**11.2**	**7.8**	**9.6**	**6.4**

Effect of weeding on annual girth increment

RAS 11a - WEST KALIMANTAN
Rubber girth at 66 months

Farmer	Low	Medium	Intense
Fransisco	25.8	28.8	29.7
Stepanus	31.9	35.9	34.6
Jampi 2	32.6	25.4	28.1
Sudin 1	31.3	32.1	28.4
Apan	32.6	28.2	33.6
Otol	26.2	32.7	35.6
average	30.06	30.52	31.67

Anova: Two-Factor Without Replication

SUMMARY	*Count*	*Sum*	*Average*	*Variance*	
Fransisco	3	84.30	28.10	4.18	
Stepanus	3	102.34	34.11	4.15	
Jampi 2	3	86.08	28.69	13.09	
Sudin 1	3	91.74	30.58	3.84	
Apan	3	94.43	31.48	8.29	
Otol	3	94.58	31.53	23.13	
Low	6	180.35	30.06	10.10	ssd 5% = 4.17
Medium	6	183.10	30.52	14.07	ssd 1% = 5.93
Intense	6	190.02	31.67	11.08	

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows	71.17	5	14.23	1.35	0.32	3.33
Columns	8.28	2	4.14	0.39	0.68	4.10
Error	105.08	10	10.51			
Total	184.53	17				

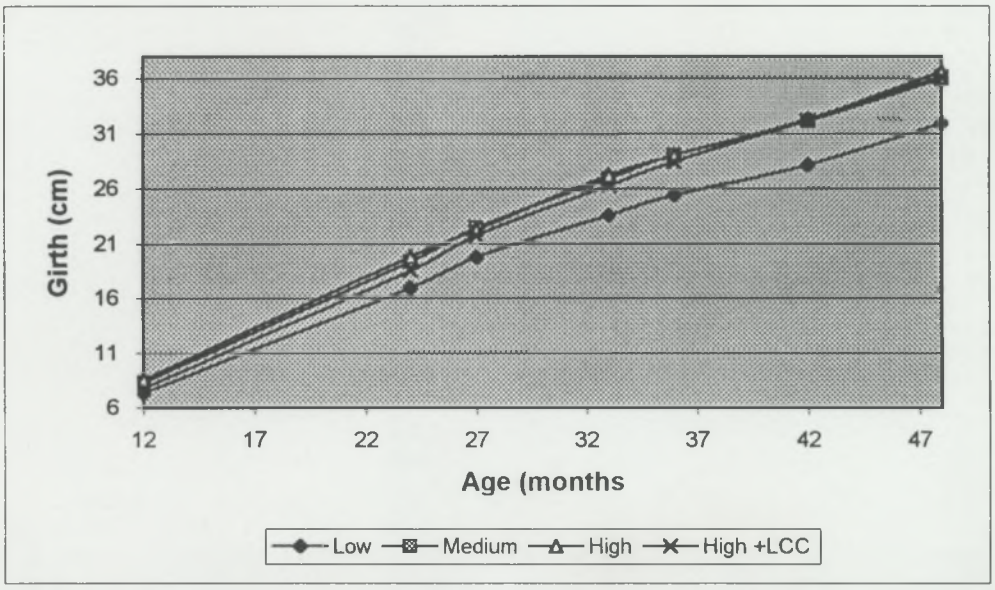
RAS 11 b - WEST KALIMANTAN
Effect of weeding and maintenance on rubber girth

Planting date: November 1996 - Embaong

Farmer	Weeding Intensity	Girth (cm)						
		Nov-97	Nov-98	Feb-98	Aug-99	Nov-99	Feb-00	Aug-00
Latin	Low	8.1	16.8	19.9	24.8	27.5	31.3	36.2
	Medium	8.8	18.5	21.8	27.3	30.6	34.8	40.5
	High	7.5	16.7	18.1	23.8	25.7	28.5	34.0
	High +LCC	7.5	15.8	18.7	23.9	26.2	28.8	33.4
Loheng	Low	5.5	13.4	15.4	16.9	18.0	19.4	22.3
	Medium	6.8	15.9	17.9	20.2	21.6	23.5	26.2
	High	8.8	18.3	19.9	23.2	24.9	27.3	30.7
	High +LCC	8.3	18.7	20.7	23.2	24.8	29.5	32.8
Sami	Low	7.7	18.0	20.8	25.4	27.3	30.9	35.9
	Medium	7.9	19.3	23.2	28.1	30.2	33.3	36.4
	High	8.4	19.5	23.1	28.0	29.8	33.5	37.2
	High +LCC	7.2	16.1	19.6	24.7	26.7	30.2	34.6
Sidon	Low	9.3	20.8	24.9	28.9	31.2	34.1	37.8
	Medium	8.8	20.9	24.1	29.6	31.4	34.8	39.5
	High	9.6	22.6	23.3	31.6	33.9	37.2	41.6
	High +LCC	8.7	21.4	26.3	31.2	33.8	37.5	42.6
Tonil	Low	7.9	19.4	22.3	26.7	28.0	31.0	34.1
	Medium	8.8	21.2	23.9	26.9	28.3	31.1	34.4
	High	8.6	20.9	24.0	28.1	29.2	31.6	36.1
	High +LCC	8.8	21.2	24.7	28.9	31.7	34.9	38.2
Doncu	Low	5.4	13.2	15.2	18.5	20.1	22.2	25.2
	Medium	8.6	20.1	23.8	29.2	32.0	35.3	38.9
	High	8.6	20.7	25.1	28.5	30.7	35.4	40.0
	High +LCC	6.2	18.0	20.5	25.6	27.3	31.9	35.3

Average	**Low**	**7.3**	**16.9**	**19.8**	**23.5**	**25.3**	**28.1**	**31.9**
	Medium	**8.3**	**19.3**	**22.5**	**26.9**	**29.0**	**32.1**	**36.0**
	High	**8.6**	**19.8**	**22.3**	**27.2**	**29.0**	**32.2**	**36.6**
	High +LCC	**7.8**	**18.5**	**21.8**	**26.3**	**28.4**	**32.1**	**36.1**

Effect of weeding on rubber growth

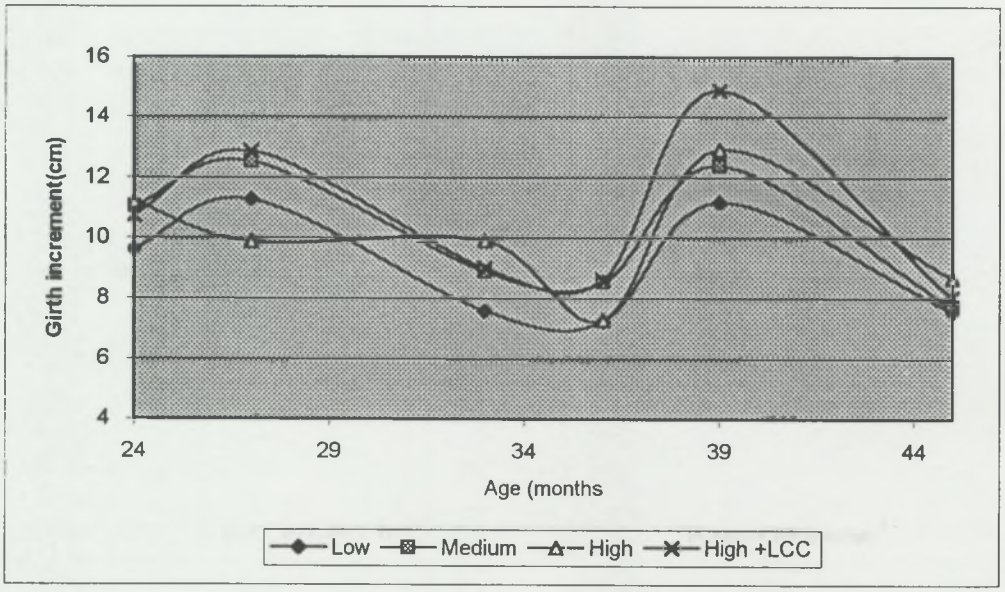


RAS 11 b - WEST KALIMANTAN
Effect of weeding and maintenance on rubber girth increment

Planting date: November 1996 - Embaong

Farmer	Weeding intensity	Annual girth increment (cm)						
		Nov-97	Nov-98	Feb-98	Aug-99	Nov-99	Feb-00	Nov-00
Latin	Low		8.7	12.4	9.8	10.7	15.1	10.0
	Medium		9.7	13.2	11.0	13.1	16.8	11.5
	High		9.2	5.6	11.4	7.6	11.2	11.0
	High +LCC		8.3	11.6	10.4	9.2	10.3	9.3
Loheng	Low		7.9	8.0	3.0	4.4	5.6	5.7
	Medium		9.1	8.0	4.6	5.7	7.3	5.5
	High		9.5	6.4	6.6	6.6	9.7	6.9
	High +LCC		10.4	8.0	5.0	6.4	18.9	6.5
Sami	Low		10.3	11.2	9.2	7.5	14.3	10.0
	Medium		11.4	15.6	9.8	8.4	12.2	6.2
	High		11.1	14.4	9.8	7.1	14.8	7.4
	High +LCC		8.9	14.0	10.2	8.0	13.8	8.9
Sidon	Low		11.5	16.4	8.0	9.1	11.6	7.5
	Medium		12.1	12.8	11.0	7.2	13.6	9.3
	High		13.0	2.8	16.6	9.1	13.5	8.7
	High +LCC		12.7	19.6	9.8	10.4	14.8	10.1
Tonil	Low		11.5	11.6	8.8	5.4	11.7	6.3
	Medium		12.4	10.8	6.0	5.5	11.2	6.7
	High		12.3	12.4	8.2	4.4	9.6	8.9
	High +LCC		12.4	14.0	8.4	11.1	13.0	6.6
Doncu	Low		7.8	8.0	6.6	6.2	8.6	5.9
	Medium		11.5	14.8	10.8	11.3	13.1	7.1
	High		12.1	17.6	6.8	8.8	18.8	9.2
	High +LCC		11.8	10.0	10.2	6.8	18.4	6.8
Average	**Low**		**9.6**	**11.3**	**7.6**	**7.2**	**11.2**	**7.6**
	Medium		**11.0**	**12.5**	**8.9**	**8.5**	**12.4**	**7.7**
	High		**11.2**	**9.9**	**9.9**	**7.3**	**12.9**	**8.7**
	High +LCC		**10.8**	**12.9**	**9.0**	**8.6**	**14.9**	**8.0**

Effect of weeding on annual girth increment



RAS 11 b - WEST KALIMANTAN
Rubber girth at 48 months

Farmer	Low	Medium	High	High+LCC
Latin	36.2	40.5	34.0	33.4
Loheng	22.3	26.2	30.7	32.8
Sami	35.9	36.4	37.2	34.6
Sidon	37.8	39.5	41.6	42.6
Tonil	34.1	34.4	36.1	38.2
Doncu	25.2	38.9	40.0	35.3
Average	31.91	35.98	36.58	36.14

Anova: Two-Factor Without Replication

SUMMARY	*Count*	*Sum*	*Average*	*Variance*	
Latin	4	144.17	36.04	10.44	
Loheng	4	111.96	27.99	21.97	
Sami	4	144.06	36.02	1.17	
Sidon	4	161.45	40.36	4.51	
Tonil	4	142.79	35.70	3.51	
Doncu	4	139.25	34.81	45.40	
Low	6	191.48	31.91	42.45	ssd 5% = 4.21
Medium	6	215.87	35.98	27.93	ssd 1% = 5.82
High	6	219.50	36.58	15.61	
High+LCC	6	216.83	36.14	13.48	

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*	
Farmers	321.58	5	64.32	5.49	0.005	2.90	**
Weeding	85.16	3	28.39	2.42	0.106	3.29	
Error	175.78	15	11.72				
Total	582.52	23					

WEST KALIMANTAN - RAS 1.1 a &b

1. Trial implementation

The trials RAS 1.1 a and b study the effect of weeding frequency in a secondary forest re-growth environment. Protocols were well followed in the first year, then farmers didn't strictly follow the weeding program. However a different intensity of weeding was maintained between treatments. The original protocol in RAS1.1a had 0, 1, and 3 weeding frequency per year but weeding frequency was changed to 4, 6, and 8 weedings per year because of weed control. RAS 1.1 b included a control with high weeding frequency and LCC established in the inter-row.

2. General observations on trial

In RAS1.1a rubber growth was very slow during the first year due to small plants at planting time. Weeding intensity didn't improve rubber growth in general but differences were observed between farms. In RAS 1.1b, intense weeding treatment and intense weeding with legume cover crop (LCC) obtained the best performances. Weeding frequency is not the only factor in weeding. Variations were observed between farms in a) weed composition in the inter-row b) quality of weeding implementation.

3. Treatment analysis

- RAS 1.1a (6 replications): Rubber girth at 66 months

Treatments (No of weeding in year 1,2,3)	Girth in cm (%)
Low weeding frequency (0, 4, 4)	30.1 (95)
Medium weeding frequency (1, 6, 6)	30.5 (96)
High weeding frequency (3, 6, 6)	31.7 (100)

No significant differences are observed between treatments. Wigh weeding frequency has increased rubber growth by only 5%!

- RAS 1.1b (6 replications): Rubber girth at 48 months

Treatments (No of weeding in year 1,2,3)	Girth in cm (%)
Low weeding frequency (4, 6, 8)	31.9 (88)
Medium weeding frequency (6, 4, 4)	36.0 (99)
High weeding frequency (8, 6, 6)	36.6 (101)
High weeding frequency (8, 6, 6) + LCC	36.2 (100)

There are no significant differences between treatments. Low intensity weeding obtained slower rubber growth than other treatment (less 10%) indicating that weeds (in particular grasses) affect rubber development.

4. Conclusion

Weeding frequency is not the only factor to be considered. In the farms, weed composition and plant density vary from one place to another. Weeding practices are important such as types of weeding (slashing, hoeing or chemical weeding), width of the weeded strip, quality of weeding in rubber circles are factors to be considered in weeding assessment.

RAS 11c -WEST KALIMANTAN

Effect of weeding and maintenance on rubber girth

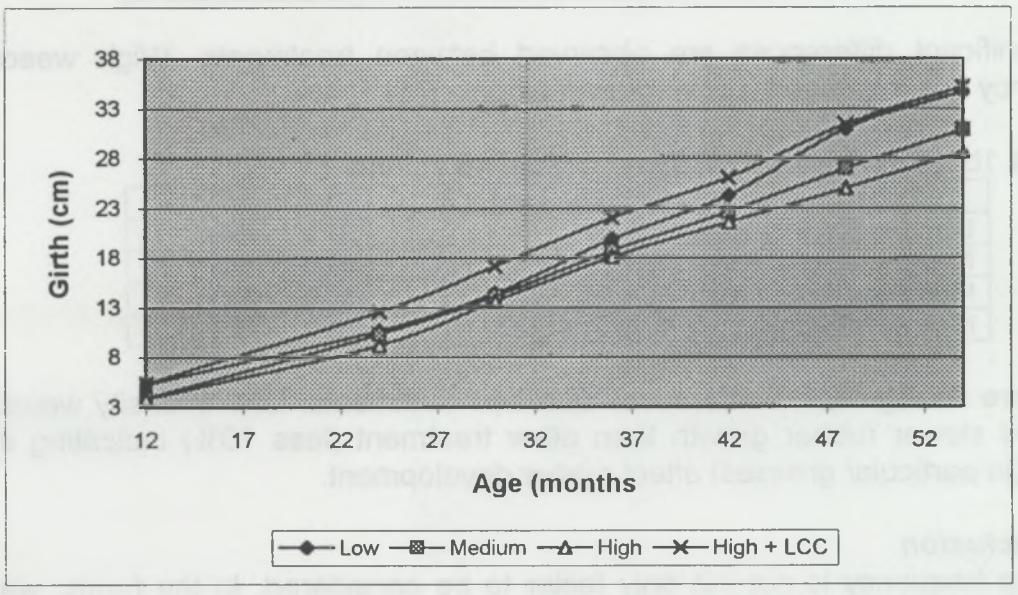
Planting date: February 1996 - Engkayu

Farmer	Weeding Intensity	Girth (cm)							
		Feb-97	Feb-98	Aug-98	Feb-99	Aug-99	Feb-00	Aug-00	
LC Lahon	Low	3.9	5.5	6.5	11.1	15.5	21.5	28.0	
	Medium	-	2.9	3.9	5.9	8.8	12.43	15.9	(1)
	High	-	1.9	4.6	5.9	8.8	10.22	13.7	(1)
	High + LCC	4.3	9.5	12.6	16.9	21.0	25.5	31.5	
Six	Low	4.5	9.4	12.9	17.9	22.1	26.2	29.8	
	Medium	4.7	9.9	13.4	18.4	22.4	27.5	31.4	
	High	4.5	8.2	11.6	16.5	19.4	23.3	27.0	
	High + LCC	4.8	10.4	14.4	17.5	22.0	26.1	29.0	
Tinus	Low	7.4	17.2	24.0	30.6	35.3	45.1	46.1	
	Medium	7.1	18.0	25.1	31.8	36.5	41.1	45.3	
	High	7.0	17.5	24.7	31.9	36.4	41.4	45.2	
	High + LCC	7.1	17.8	24.6	31.7	35.2	42.8	44.9	

(1) Many supplies

Average	**Low**	**5.3**	**10.7**	**14.5**	**19.9**	**24.3**	**31.0**	**34.6**
	Medium	**3.9**	**10.3**	**14.1**	**18.7**	**22.6**	**27.0**	**30.9**
	High	**3.8**	**9.2**	**13.6**	**18.1**	**21.5**	**25.0**	**28.7**
	High + LCC	**5.4**	**12.6**	**17.2**	**22.0**	**26.1**	**31.4**	**35.1**

Effect of weeding on rubber growth



RAS 11c -WEST KALIMANTAN

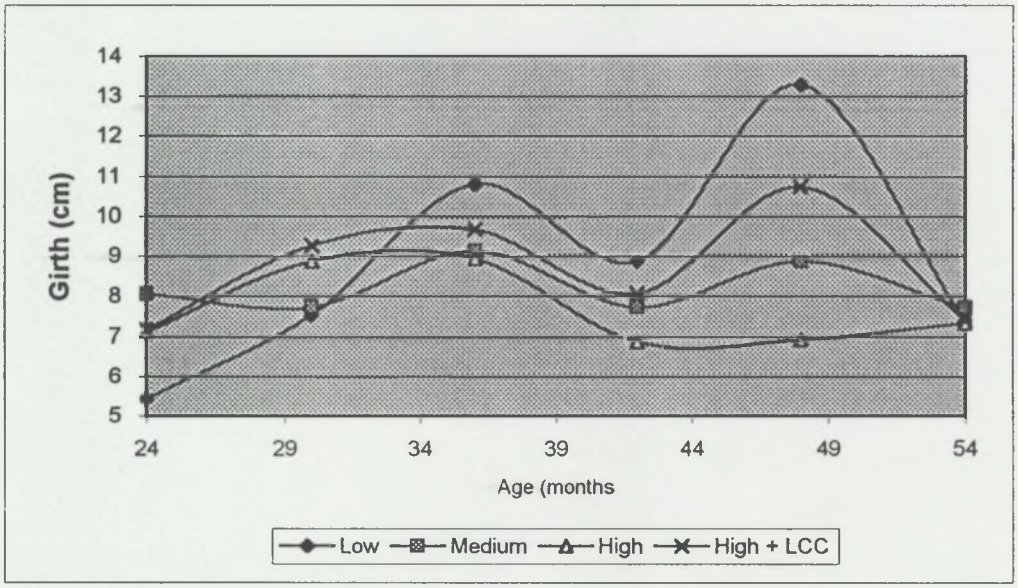
Effect of weeding and maintenance on rubber girth increment

Planting date: February 1996 - Engkayu

Farmer	Weeding Intensity	Annual girth increment (cm)					
		Feb-97	Feb-98	Aug-98	Feb-99	Aug-99	Feb-00	Aug-00
LC Lahong	Low	1.6	2.0	9.2	8.8	12.0	13.0
	Medium		2.0	4.0	5.8	7.3	6.9
	High		5.4	2.6	5.8	2.8	7.0
	High + LCC	5.2	6.2	8.6	8.2	8.9	12.1
Six	Low	4.9	7.0	10.0	8.4	8.3	7.2
	Medium	5.2	7.0	10.0	8.0	10.1	7.9
	High	3.7	6.8	9.8	5.8	7.8	7.4
	High + LCC	5.6	8.0	6.2	9.0	8.1	5.8
Tinus	Low	9.8	13.6	13.2	9.4	19.6	2.0
	Medium	10.9	14.2	13.4	9.4	9.3	8.3
	High	10.5	14.4	14.4	9.0	10.0	7.5
	High + LCC	10.7	13.6	14.2	7.0	15.2	4.3

Average	**Low**	**5.4**	**7.5**	**10.8**	**8.9**	**13.3**	**7.4**
	Medium	**8.1**	**7.7**	**9.1**	**7.7**	**8.9**	**7.7**
	High	**7.1**	**8.9**	**8.9**	**6.9**	**6.9**	**7.3**
	High + LCC	**7.2**	**9.3**	**9.7**	**8.1**	**10.7**	**7.4**

Effect of weeding on rubber growth



WEST KALIMANTAN - RAS 1.2/CLONE COMPARISON

TITLE:
Clonal rubber in agroforestry environment: genotype x environment interaction.
Clone/seedlings (control) comparison

OBJECTIVE/HYPOTHESE

Objectives
- To investigate the growth of 4 improved rubber clone and seedlings in RAS 1 environment (close to jungle rubber conditions), under 2 intensities of weeding (4 and 8 weeding/year), with emphasis on the critical first 2 years of establishment.

Hypotheses

Main Hypothesis
- Increasing intensity of weeding within the rubber row (compared to that of unselected seedlings) will result in greater growth of rubber due to a decrease in intensity of below-ground competition from regenerating secondary forest species, taking into account the fact that clones required more weeding than unselected seedlings (Note : clones have never been tested in close to jungle rubber conditions). Some clones may be more adapted than other for RAS 1 among those 4 clones, which have been selected for all RAS trials. Seedlings as a control will permit the growth and production comparison with clones in jungle rubber conditions.

EXPECTED OUTPUTS
- To produce recommendations on clonal recommendations in RAS 1.

LOCATION: West-Kalimantan province, Kabupaten Sanggau, Kecamatan Sanggau Kapuas, villages of Embaong. Total 4 replications for October 1996 planting.

YEAR:
Rubber planting: October 1996

DURATION
5 to 6 years for immature period. The first 2 years are critical in terms of growth and survivability. Then, if possible, a minimum of 3 years of production monitoring.

MATERIALS AND METHOD
DESIGN: 10 plots **code : 1a_1296N or code F**
Treatments
Treatment 1: clones (4) + seedlings
Treatment 2: weeding intensity : 4 and 8 weeding/year for the first year.

TRIAL DESIGN

Seedlings 4 weeding/year	PB 260 4 weeding/year	RRIC 100 4 weeding/year	BPM 1 4 weeding/year	RRIM 600 4 weeding/year
Seedlings 8 weeding/year	PB 260 8 weeding/year	RRIC 100 8 weeding/year	BPM 1 8 weeding/year	RRIM 600 8 weeding/year

Weeding protocol: year 2 and after:

For RAS 1.2

PLOT/year	1	2	3	4	5
A	4x	3x	2x	2x	2x
B	8x	6x	4X	4X	4X

Note in West Kalimantan: one every 2 weeding is done with Round Up.

EXPERIMENTAL DESIGN
Strip Split plot with main treatment on clones/seedlings, secondary treatment on weeding level.

RUBBER
FERTILIZATION
TCSDP fertilization program (N-P-K-CA) only for the first 2 years. No fertilization later.

In g/tree

	Planting time	+ 3 months	+ 6 months	+ 9 months	+ 12 months
CA	40	40	40	40	
Urea		50	50	50	50
SP36	540	40	40	40	40
KCL			25	25	25

In kg/ha	planting time	+ 3 months	+ 6 months	+ 9 months	+ 12 months
CA in kg/ha	22	22	22	22	
UREA kg/ha		28	28	28	28
SP36 kg/ha	300	22	22	22	22
KCL kg/ha			14	14	14

Rubber planting distance
Standard : 550 trees/ha : 3 x 6 meters.

INTERCROPPING
Local rice the first year with some palawijas such as corn and cassava.

INTER ROW DURING IMMATURE PERIOD
The secondary forest (belukar) is allowed to grow at the conditions that trees and shrubs do not reach a height greater than that of rubber (selective cutting if necessary).

DESIGN

PLOT SIZE :	800 m
NUMBER OF PLOTS PER REPLICATION:	10 plots
REPLICATION/FARM SIZE:	8 000 m
NUMBER OF REPLICATION per trial =	4
TOTAL SIZE OF 1TRIAL:	3.2 ha

DATA TO BE COLLECTED

Standard data for ail RAS 1:

- rubber growth measurements : diameter, height and whorls the first year every 3 months. Then girth the second year every 3 months. Sample of 30 trees per plot (4 plots per rep).
- Farmer's labor for each plot.
- soil samples per replication on 0-10 and 10-20 cm.
- rice production.
- Labor requirement per plot.

RAS 12a - WEST KALIMANTAN

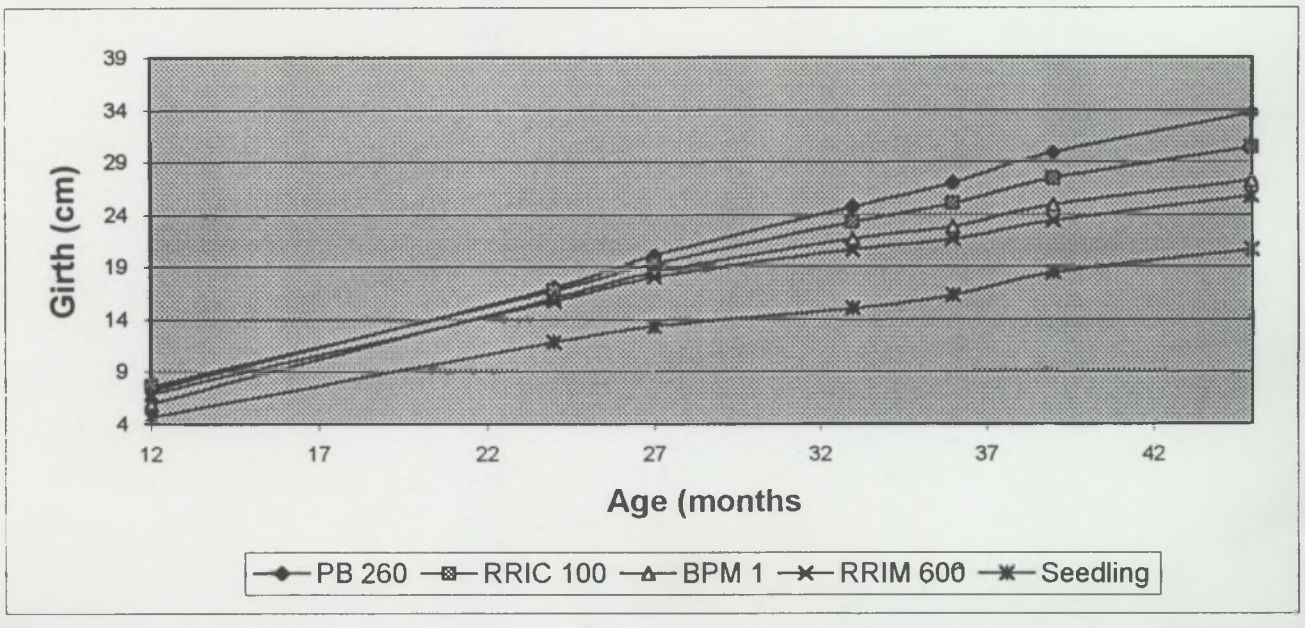
Performances of different rubber clones in near jungle rubber environment (RAS1)

Planting date: November 1996 - Embaong

Farmer	Clone	Girth (cm)													
		Low weeding							High weeding						
		Nov-97	Nov-98	Feb-99	Aug-99	Nov-99	Feb-00	Aug-00	Nov-97	Nov-98	Feb-99	Aug-99	Nov-99	Feb-00	Aug-00
Aloysius	PB 260	8.1	18.6	21.8	26.3	28.3	31.5	35.1	9.0	20.6	24.2	30.6	32.3	37.1	41.0
	RRIC 100	6.7	15.2	17.5	20.5	21.6	23.8	26.0	9.2	19.1	21.8	26.4	28.3	31.5	35.2
	BPM 1	4.8	11.5	12.6	14.5	14.5	15.4	16.5	8.3	18.6	20.9	24.0	25.3	27.6	29.5
	RRIM 600	6.2	15.4	17.5	20.0	21.3	23.8	25.0	8.2	17.3	19.4	21.9	22.9	25.5	27.7
	Seedling	4.2	12.8	14.2	16.2	17.0	18.7	19.9	4.3	10.8	12.3	14.2	15.3	17.1	18.1
Lidi	PB 260	6.6	16.1	19.2	20.7	24.1	26.5	29.3	7.4	16.0	18.7	22.1	23.5	25.2	28.2
	RRIC 100	6.4	16.3	19.1	22.7	24.5	26.5	28.5	7.9	17.4	20.6	25.3	26.7	28.8	30.8
	BPM 1	6.4	16.3	19.0	22.9	23.2	24.7	26.4	5.1	14.3	16.6	20.0	21.1	22.8	24.5
	RRIM 600	7.7	18.2	20.9	23.7	24.5	26.3	28.4	5.9	13.3	15.9	17.7	18.5	19.2	20.3
	Seedling	6.2	15.2	17.0	18.5	19.4	21.5	23.9	4.8	12.1	13.6	14.3	15.7	17.4	19.4
Jampi 1	PB 260	6.6	15.0	18.5	24.2	26.2	28.7	32.4	5.3	13.9	16.4	22.1	24.3	28.5	31.2
	RRIC 100	6.1	15.6	18.7	24.9	27.5	30.9	35.4	8.0	17.5	20.3	23.7	26.0	29.6	30.9
	BPM 1	7.1	16.3	19.2	23.2	24.8	27.2	31.2	-	12.4	15.3	17.3	18.5	22.2	24.7
	RRIM 600	6.5	15.2	17.2	20.9	21.9	23.7	26.2	5.9	14.6	17.1	20.3	21.6	23.9	26.1
	Seedling	2.8	7.7	8.9	11.1	12.6	15.1	17.3	2.3	7.2	9.3	12.1	13.3	16.2	18.8
Cacot	PB 260	7.9	18.4	21.7	27.1	30.1	32.8	38.0	7.3	17.6	20.2	24.7	26.9	28.8	34.1
	RRIC 100	9.7	16.6	18.4	21.4	22.7	24.0	27.8	6.7	15.7	17.7	21.3	22.9	24.3	28.4
	BPM 1	8.3	19.5	21.9	25.4	27.3	29.4	31.9	7.7	19.4	22.1	26.0	28.1	29.7	33.0
	RRIM 600	6.8	15.4	17.5	19.5	20.9	23.0	26.0	7.9	16.3	18.2	20.8	21.1	21.9	26.3
	Seedling	7.3	15.7	17.3	18.4	21.0	24.0	27.1	5.3	13.0	14.1	15.5	15.8	17.1	20.2

Average	**PB 260**	**7.3**	**17.0**	**20.3**	**24.6**	**27.2**	**29.9**	**33.7**	**7.3**	**17.0**	**19.9**	**24.9**	**26.8**	**29.9**	**33.6**
	RRIC 100	**7.2**	**15.9**	**18.4**	**22.4**	**24.1**	**26.3**	**29.4**	**8.0**	**17.4**	**20.1**	**24.2**	**26.0**	**28.6**	**31.3**
	BPM 1	**6.7**	**15.9**	**18.2**	**21.5**	**22.4**	**24.2**	**26.5**	**5.3**	**16.2**	**18.7**	**21.8**	**23.2**	**25.6**	**27.9**
	RRIM 600	**6.8**	**16.1**	**18.3**	**21.0**	**22.1**	**24.2**	**26.4**	**7.0**	**15.4**	**17.7**	**20.2**	**21.0**	**22.6**	**25.1**
	Seedling	**5.1**	**12.9**	**14.4**	**16.1**	**17.5**	**19.8**	**22.0**	**4.2**	**10.8**	**12.3**	**14.0**	**15.0**	**17.0**	**19.1**

Rubber growth according to clone



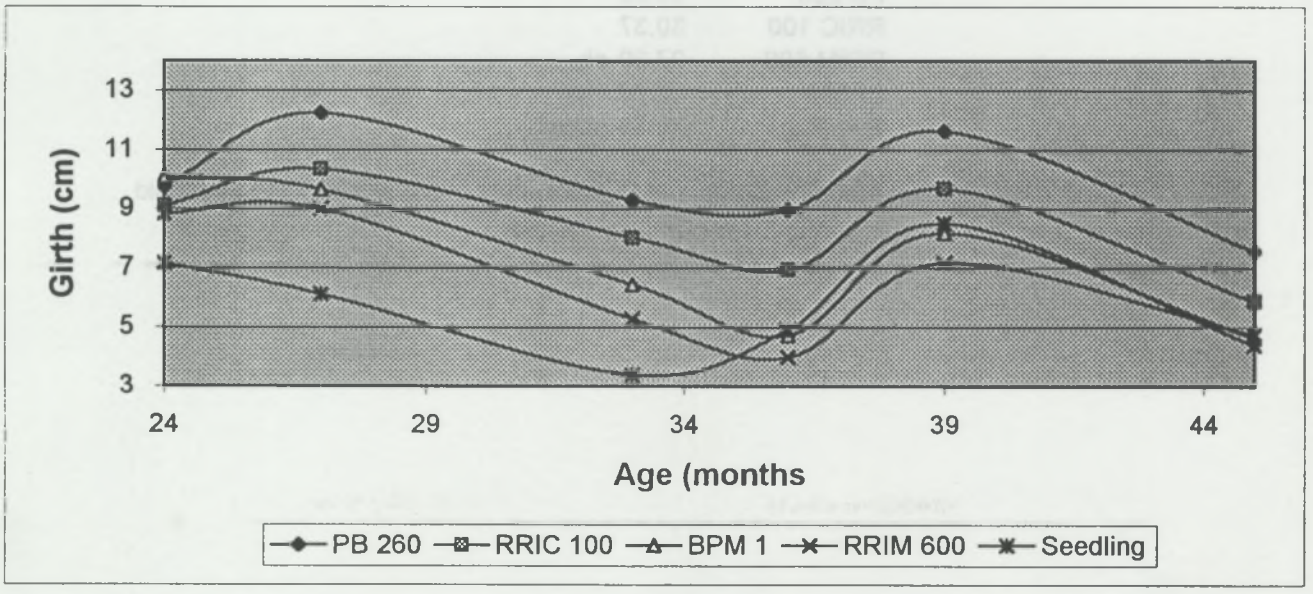
RAS 12a - WEST KALIMANTAN

Annual girth increment of different rubber clones

Planting date: November 1996 - Embaong

Farmer	Clone	Girth (cm)											
		Low weeding						High weeding					
		Nov-97	Nov-98	Feb-99	Aug-99	Nov-99	Feb-00	Aug-00	Nov-97	Nov-98	Feb-99	Aug-99	Nov-99	Feb-00	Aug-00
Aloysius	PB 260		10.5	12.8	9.0	7.8	12.9	7.3		11.6	14.4	12.8	6.8	19.1	7.9
	RRIC 100		8.5	9.2	6.0	4.2	8.8	4.5		9.9	10.8	9.2	7.4	12.9	7.4
	BPM 1		6.7	4.4	3.8	(0.2)	4.0	2.0		10.3	9.2	6.2	5.3	9.2	3.7
	RRIM 600		9.2	8.4	5.0	5.2	9.8	2.5		9.1	8.4	5.0	4.1	10.3	4.5
	Seedling		8.6	5.6	4.0	3.3	6.8	2.3		6.5	6.0	3.8	4.4	7.2	2.1
Lidi	PB 260		9.5	12.4	3.0	13.7	9.5	5.6		8.6	10.8	6.8	5.7	6.8	5.9
	RRIC 100		9.9	11.2	7.2	7.2	8.0	4.0		9.5	12.8	9.4	5.4	8.5	4.1
	BPM 1		9.9	10.8	7.8	1.0	6.1	3.4		9.2	9.2	6.8	4.3	6.9	3.4
	RRIM 600		10.5	10.8	5.6	3.1	7.3	4.2		7.4	10.4	3.6	3.2	2.7	2.3
	Seedling		9.0	7.2	3.0	3.5	8.6	4.8		7.3	6.0	1.4	5.4	7.1	4.0
Jampi 1	PB 260		8.4	14.0	11.4	8.0	9.9	7.4		8.6	10.0	11.4	8.8	16.6	5.6
	RRIC 100		9.5	12.4	12.4	10.3	13.8	9.0		9.5	11.2	6.8	9.2	14.5	2.5
	BPM 1		9.2	11.6	8.0	6.4	9.8	8.0		12.4	11.6	4.0	4.8	14.8	4.9
	RRIM 600		8.7	8.0	7.4	4.0	7.1	5.0		8.7	10.0	6.4	5.2	9.1	4.5
	Seedling		4.9	4.8	4.4	6.0	9.9	4.4		4.9	8.4	5.6	4.9	11.6	5.1
Cacot	PB 260		10.5	13.2	10.8	12.1	10.7	10.3		10.3	10.4	9.0	8.8	7.6	10.6
	RRIC 100		6.9	7.2	6.0	5.3	5.2	7.5		9.0	8.0	7.2	6.5	5.6	8.1
	BPM 1		11.2	9.6	7.0	7.8	8.2	5.1		11.7	10.8	7.8	8.4	6.5	6.7
	RRIM 600		8.6	8.4	4.0	5.6	8.2	6.0		8.4	7.6	5.2	1.3	3.0	8.8
	Seedling		8.4	6.4	2.2	10.6	11.7	6.2		7.7	4.4	2.8	1.2	5.1	6.2
Average	**PB 260**		**9.7**	**13.1**	**8.6**	**10.4**	**10.8**	**7.7**		**9.8**	**11.4**	**10.0**	**7.5**	**12.5**	**7.5**
	RRIC 100		**8.7**	**10.0**	**7.9**	**6.8**	**9.0**	**6.2**		**9.5**	**10.7**	**8.2**	**7.1**	**10.4**	**5.5**
	BPM 1		**9.3**	**9.1**	**6.7**	**3.7**	**7.0**	**4.6**		**10.9**	**10.2**	**6.2**	**5.7**	**9.4**	**4.7**
	RRIM 600		**9.3**	**8.9**	**5.5**	**4.5**	**8.1**	**4.5**		**8.4**	**9.1**	**5.1**	**3.5**	**6.3**	**5.0**
	Seedling		**7.7**	**6.0**	**3.4**	**5.8**	**9.2**	**4.4**		**6.6**	**6.2**	**3.4**	**4.0**	**7.8**	**4.3**

Annual girth increment according to rubber clone



RAS 12a - WEST KALIMANTAN
Rubber girth at 45 months

	PB 260	RRIC 100	BPM 1	RRIM 600	Seedling
Aloysius	38.08	30.59	22.98	26.38	19.01
Lidi	28.75	29.66	25.44	24.36	21.68
Jampi 1	31.81	33.16	27.93	26.16	18.03
Cacot	36.01	28.07	32.48	26.13	23.62
Average	33.66	30.37	27.20	25.76	20.58

Anova: Two-Factor Without Replication

SUMMARY	*Count*	*Sum*	*Average*	*Variance*	
Aloysius	5	137.02	27.40	53.83	
Lidi	5	129.88	25.98	10.65	
Jampi 1	5	137.08	27.42	35.57	
Cacot	5	146.30	29.26	24.75	
PB 260	4	134.65	33.66	17.55	
RRIC 100	4	121.47	30.37	4.53	
BPM 1	4	108.82	27.20	16.44	lsd 5% = 4.67
RRIM 600	4	103.02	25.76	0.88	lsd 1% = 6.55
Seedling	4	82.33	20.58	6.48	

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*	
Farmer	27.16	3	9.05	0.98	0.433	3.49	
Rubber clone	388.74	4	97.18	10.56	0.001	3.26	**
Error	110.46	12	9.20				
Total	526.36	19					

PB 260	33.66	
RRIC 100	30.37	
RRIM 600	27.20	ab
BPM 1	25.76	ab
Seedling	20.58	abcd

a,b,c,d: Classification groups according to Duncan's test at 5% significance threshold

RAS 12b -WEST KALIMANTAN

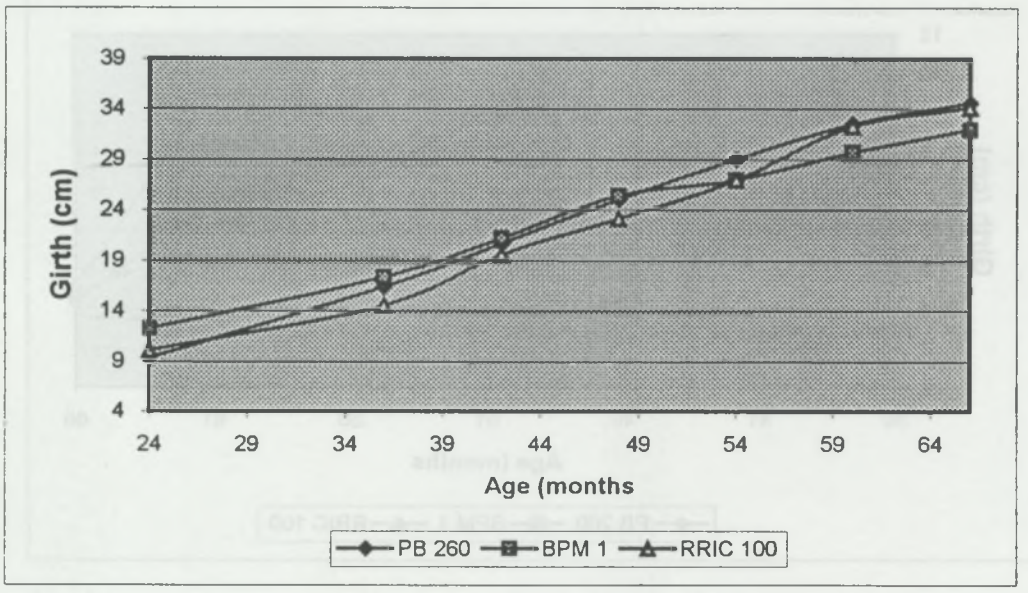
Performances of different rubber clones in near jungle rubber environment (RAS1)

Planting date: February 1995 - Engkayu 1

Farmer	Clone	Girth (cm)						
		Feb-97	Feb-98	Aug-98	Feb-99	Aug-99	Feb-00	Aug-00
Gabriel rep1	PB 260	9.9	19.3	23.2	29.9	33.7	37.9	40.2
	BPM 1	13.9	17.4	21.8	25.8	26.7	29.6	32.1
	RRIC 100	10.3	12.8	18.3	22.2	26.5	30.6	32.5
Gabriel rep2	PB 260	8.7	13.4	18.1	20.2	24.3	27.1	29.0
	BPM 1	10.5	17.3	20.6	25.1	27.2	29.8	31.8
	RRIC 100	9.8	16.2	20.8	24.1	27.4	33.0	35.6

Average	**PB 260**	**9.3**	**16.4**	**20.7**	**25.1**	**29.0**	**32.5**	**34.6**
	BPM 1	**12.2**	**17.4**	**21.2**	**25.5**	**27.0**	**29.7**	**31.9**
	RRIC 100	**10.1**	**14.5**	**19.6**	**23.2**	**27.0**	**31.8**	**34.1**

Rubber growth according to clone



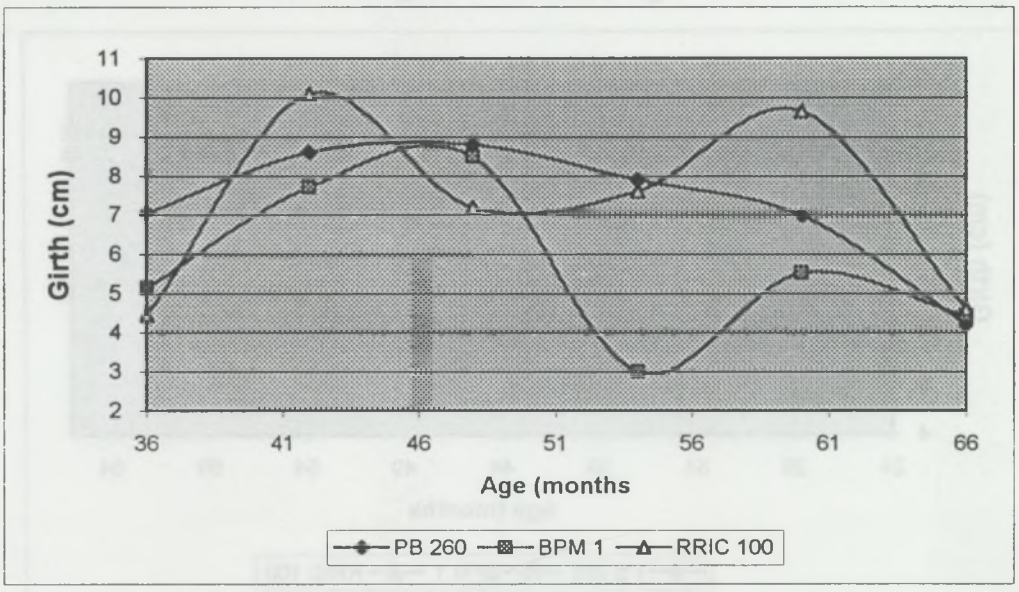
RAS 12b -WEST KALIMANTAN

Annual girth increment of different rubber clones

Planting date: February 1995 - Engkayu 1

Farmer	Clone	Annual girth increment (cm)						
		Feb-97	Feb-98	Aug-98	Feb-99	Aug-99	Feb-00	Aug-00
Gabriel 1	PB 260		9.4	7.8	13.4	7.6	8.4	4.5
	BPM 1		3.5	8.8	8.0	1.8	5.9	4.9
	RRIC 100		2.5	11.0	7.8	8.6	8.1	3.9
Gabriel 2	PB 260		4.7	9.4	4.2	8.2	5.6	3.9
	BPM 1		6.8	6.6	9.0	4.2	5.2	3.9
	RRIC 100		6.4	9.2	6.6	6.6	11.2	5.3
Average	**PB 260**		**7.1**	**8.6**	**8.8**	**7.9**	**7.0**	**4.2**
	BPM 1		**5.2**	**7.7**	**8.5**	**3.0**	**5.5**	**4.4**
	RRIC 100		**4.5**	**10.1**	**7.2**	**7.6**	**9.7**	**4.6**

Annual girth increment of different clones



WEST KALIMANTAN - RAS 1.2 a &b

1. Trial implementation

Trials RAS 1.2a and RAS 1.2b compare different rubber planting material: four high yielding clones vs. rubber seedlings in RAS 1 environment. The rubber clones are very promising but they were never tested in a jungle rubber-like environment. Clones are observed for disease incidence: leaf spots *Colletotricum* and *Corynospora*, pink disease and white root disease.

2. General observations on trial

After 36 months rubber clones performed satisfactorily as the average girth increment in the four clones is 8.1 cm/year, slightly inferior to standard increment in rubber estates (9 cm/year). Rubber seedlings are inferior to rubber clones.

3. Treatment analysis

- RAS 1.2a (4 replications): rubber girth at 45 months

Treatments	Girth in cm (%)
PB 260	33.7 (100) a
RRIC 100	30.4 (90) a
BPM 1	27.2 (81) b
RRIM 600	25.8 (77) b
Clonal seedlings	20.6 (61) c

Two clones PB 260 and RRIC 100 grow faster than others, and the four rubber clones have a girth significantly bigger than clonal seedlings.

- RAS 1.2a (2 replications): rubber girth at 66 months

Treatments	Girth in cm (%)
PB 260	34.6 (100)
BPM 1	31.9 (92)
RRIC 100	34.1 (99)

PB 260, as in RAS 1.2a trial, obtained the fastest growth amongst rubber clones. BPM 1 had an early leaf fall that delay girth development during 6 months

4. Conclusion

Rubber clones are performing well in RAS 1 conditions and they outperform rubber seedlings presumably more resistant in unfavorable environment. Two rubber clones PB 260 and RRIC 100 obtained the best growth. Farmers have already adopted PB260 clone for their own development as this clone is widely used in nurseries conducted by smallholders.

WEST KALIMANTAN - RAS 2.1/
Association with Timber and Fruit trees

TITLE
Clonal rubber in agroforestry environment: rubber + selected associated trees + intercropping
Treatment on type of timber and fruit trees associated to rubber.

OBJECTIVE/HYPOTHESE

Objectives

As in jungle rubber system where rubber seedlings are associated with various kind of trees and plants, RAS 2.2 aims to associate useful trees (fruits and timber trees) with rubber, at a limited planting density, without substantial decrease in rubber yield.

The objective of this trial is to study the competition level between rubber and various types of associated trees according to a tree typology (see in appendix).
Rubber is planted at normal planting density of 550/ha. Associated trees are planted at 92 trees/ha.

Hypotheses

General to RAS 2:
- It is expected that rubber growth during immature period will not be affected by associated trees competition as these selected fruits and timber trees have generally a slow growth pattern (in particular for durian , local fruits and timber species).
- It is expected that intercropping during the first 3 or 4 years of rubber immature period will create a favorable environment for a good rubber growth due to intercrop weeding and secondary effect of fertilization. Intercropping will limit the extend of weeds such as Imperata.

Specific to RAS 2.1:
- Some trees may have a very limited competition effect due to the shape of their canopy or their capacity to absorb N (leguminosae) such as *Petai*.
- Some other trees, in the same niche as rubber may be more competitive after the year 10 or 15 such as duku or rambutan or more after 20 years (durian and timber trees).
- The light competition of associated trees related to rubber is limited due to low planting density (92 trees/ha) and limited number of high and big trees.

EXPECTED OUTPUTS

To produce recommendations on tree association in RAS 2 and 3 systems:
- distribution of species for associated trees.

LOCATION : West-Kalimantan province, Kabupaten Sanggau, village of Trimulia (transmigration area).
6 rep.

YEAR :
Rubber planting: February 1996

DURATION
5 years for immature period. The first 2 years are critical in terms of growth and survivability. Then, if possible, a minimum of 3 years of production monitoring.

MATERIALS AND METHOD **code file 1a_2196 or H**

Treatments : on associated trees species : 5 treatments :
All treatments with rice intercropping, 6 rubber weeding/ year on the row.
(100cm on either side of the trees).

1 **Control:** = Rubber alone. No associated trees.
2 **Associated trees** = Durian : planting density 92 trees/ha (9 x 12 m)
3 **Associated trees** = Rambutan : planting density 92 trees/ha (9 x 12 m)
4 **Associated trees** = Durian + rambutan : planting density 92 trees/ha (9 x 12 m) : durian = 20/ha
5 **Associated trees** = combination of timber and fruit trees : planting density 92 trees/ha (9 x 12 m)

EXPERIMENTAL DESIGN
Randomized block system

RUBBER

All replications are planted with PB 260

FERTILIZATION
TCSDP fertilization program for Urea only for the first 2 years. No fertilization later.

Rubber planting distance
Standard: 550 trees/ha: 3 x 6 meters.

Rubber weeding:

6 weeding a year, every 2 months, on a regular basis.

INTERCROPPING

Same for all plots :
Local rice + recommended fertilization (100 kg urea + 130 kg SP 36 + 75 kg KCL). Urea is provided in 3 periods: planting time, + 40 days and + 80 days after planting.

Weeding: 2 weeding during growth.

ASSOCIATED TREES

No fertilization.
Weeding: same as for rubber (6 weeding/year).

FIELD SIZE

PLOT SIZE: 1000 m2
NUMBER OF PLOTS PER REPLICATION: 5 plots
REPLICATION/FARM SIZE: 5 000 m2
NUMBER OF REPLICATION 6
TOTAL SIZE OF THE TRIAL: 3 ha

DATA TO BE COLLECTED

Standard data for all RAS 2:

RUBBER

- rubber growth measurements : diameter, height and whorls the first year every 3 months. Then girth the second year every 3 months. Sample of 30 trees per plot.
- Farmer's labor for each plot.
- soil samples per replication on 0-10 and 10-20 cm.

ASSOCIATED TREES

- tree growth measurements : girth every year at planting anniversary time for all trees per plot.

RICE (the first 3 years)

- date of planting
- date of harvest
- yield of 100 m2 square at 14 % water content

PALAWIJA (if any in dry season)

- distribution of crops and average planting density
- date of planting for each crop
- date of harvest for each crop
- Estimated yield.

for RAS 2 and 3
for Kopar/Engggayu Kelompok 1, Trimulia

WEEDING LEVEL Number of weeding per year Year 1 and 2	WEEDING LEVEL Number of weeding per year Year 3	TYPE OF WEEDING In the rubber row
6 X	4x	n° 1 round-up N° 2 manual N° 3 round-up N° 4 manual

The new weeding regime begins in January 1998

For all RAS 2 and 3 plots: 4 weeding per year beginning in January 1998.

If no Alang 2: Round-up is replaced by Gramoxone.

In Trimulia and SPP Karya : if there is intercropping on the total surface of the field, including the rubber row : no use of herbicide.

APPENDIX

Identification of RAS Intercrop trees Groups:
Operational typology of trees for RAS

We recognize five types of perennials that may be associated with rubber.

- ***Group 1. Emergent species.*** Planted simultaneously with rubber, emerge above the rubber canopy, and continue productivity during and after the mature period of rubber. A rubber garden including these species may evolve into a permanent mixed perennial garden after the rubber has ceased active production. This class is typified by fruit trees such as durian, and timber species such as tengkawang, meranti, sunghai, tekam, keladan, nyatoh, penyaoh.....

Group 1 will be divided in 2 sub-groups:

- Group 1.1 : emergent species with low shadow capacity : such as Durian. Durian is used in many agroforestry systems in Indonesia with a relatively low shading on other associated trees even with relatively high planting density such as 50 trees/ha. However we don't know what is the level of shade rubber can stand with durian and durian is among the most important tree to be intercropped according to farmers' demand.
- Group 1.2 : emergent species with high shadow capacity : such as tengkawang, meranti. These trees may become competitive in term of light only after 15 years.

Group 2. Shade-established components. These are trees that require shading during their early growth, and are therefore planted 3-4 years after rubber is established. They may eventually emerge above the rubber canopy, and continue to produce after rubber is mature. They may serve to evolve the rubber system into a permanent mixed perennial garden as with group 1. This group is typified by fruit trees such as langsat/duku, and timber trees such as ironwood/belian.

Group 2 is divided in 2 sub-groups :

- Group 2.1 : associated trees in similar niche at maturity, such as duku
- Group 2.2 : associated trees as emergent species at maturity such as belian.

As trees from the groupe 2.2 have a similar behavior in term of competition at maturity stage to group 1, only trees from the group 2.1 will be taken into account. The objective is to observe the growth and the possible competition of trees planted under the shade of rubber.

Group 3. Similar niche components. Planted simultaneously with rubber (group 1), or planted a few years after rubber (group 2.1). These trees tend to occupy the same niche as rubber. Therefore, they may be strongly competitive according to planting density. This group is typified by rambutan, petai, and jengkol. However, the level of light competition my be very different between a rambutan, similar to rubber and petai for instance, a leguminous tree with ver small leaves with an expected low impact in term of light competition.

Group 3 is divided in 2 sub-groups :

- Group 3.1 : associated trees in similar niche at maturity with expected low light competition capability, such as petai.
- Group 3.2 : associated trees in similar niche at maturity with possible expected light competition capability, such as rambutan.

Group 4. Understory species. These are short-stature components planted simultaneously with rubber. They serve as cash crops during the juvenile phase of rubber. They are typified by coffee, cinnamon, and cocoa.
Coffee and cocoa have some prospected in rubber growing areas. Emphasis is put on cinnamon (with the existing planting dynamic in central Sumatra, in particular in the piedmont of the Barisan mountains). This should be limited to cinnamon in the Jambi province.

Group 5. Keystone species for natural biodiversity. These are species that attract fruit-eating fauna and speed up the process of biodiversity restoration in rubber gardens. They are typified by Ficus sp. No particular trial will take into account this tree group as there is no direct economic interest to crop such trees. Planting 2 or 3 group 5 Trees seems to be sufficient per hectare. The consequent evolution in biodiversity may be studied separately.

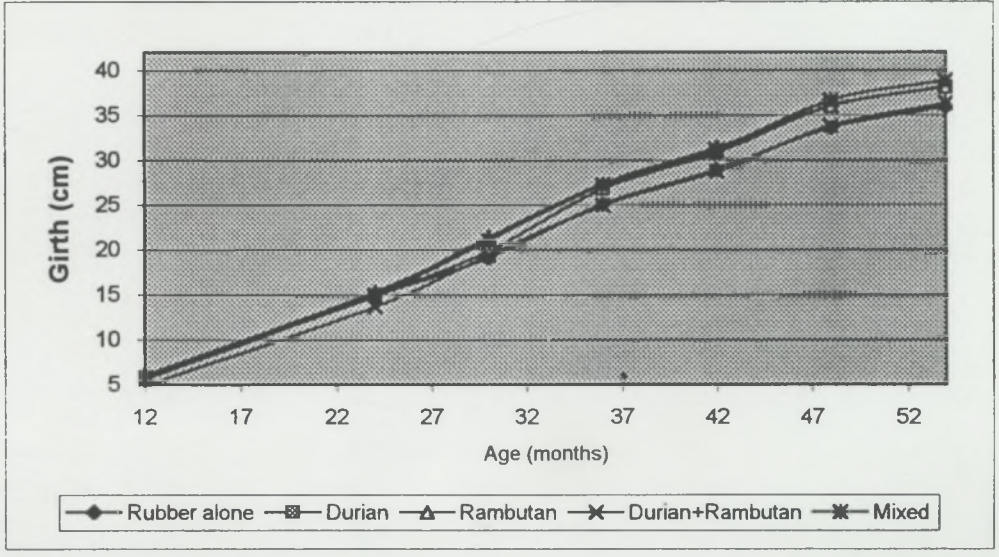
RAS 21a - WEST KALIMANTAN
Effect of fruit trees intercropping on rubber girth

Planting February 1996 - Trimulia

Farmer	Plot	Associated Trees	Girth (cm)							
			Feb-97	Feb-98	Aug-98	Feb-99	Aug-99	Feb-00	Aug-00	
Marjo	A	Rubber	3.5	10.4	16.1	22.6	26.4	30.3	33.0	
	B	Durian	3.0	8.1	12.8	19.8	23.7	29.1	30.6	
	C	Rambutan	4.9	15.6	21.9	28.6	32.5	36.3	37.4	
	D	Durian+Rambutan	3.9	12.4	19.7	23.5	26.8	30.7	32.0	
	E	Mixed	2.0	9.0	14.1	19.6	23.0	28.3	30.7	
Yasdi	A	Rubber	6.7	17.7	24.6	31.0	34.6	39.7	43.4	
	B	Durian	7.9	18.1	24.1	30.3	34.2	38.6	41.0	
	C	Rambutan	7.7	17.3	23.5	29.5	32.8	38.3	40.1	
	D	Durian+Rambutan	7.2	17.3	23.5	28.3	32.4	37.5	42.0	
	E	Mixed trees	7.3	18.9	25.6	32.1	36.3	41.3	43.4	
Sardi	A	Rubber	4.2	14.4	20.5	25.7	29.8	34.0	36.4	
	B	Durian	3.1	3.2	7.4	11.1	13.5	17.0	20.9	*(Fire)*
	C	Rambutan	4.7	11.1	17.3	22.6	27.2	31.6	35.4	
	D	Durian+Rambutan	4.3	4.9	9.9	14.0	17.5	21.7	24.6	*(Fire)*
	E	Mixed trees	4.3	12.1	18.3	23.6	27.8	32.9	35.3	
Priyo	A	Rubber	5.8	12.7	12.0	17.4	21.0	25.5	26.7	
	B	Durian	4.9	13.6	15.2	21.9	25.7	31.5	33.4	
	C	Rambutan	4.2	10.1	14.8	20.5	24.3	29.3	32.1	
	D	Durian+Rambutan	3.7	10.1	14.8	19.5	22.7	28.0	30.0	
	E	Mixed trees	6.4	12.9	18.1	24.5	28.4	33.4	36.4	
Sadianto	A	Rubber	7.1	15.7	21.8	28.5	32.8	38.5	39.4	
	B	Durian	7.9	18.4	24.5	32.0	35.6	40.9	42.0	
	C	Rambutan	7.3	18.0	25.0	31.2	34.8	39.3	39.7	
	D	Durian+Rambutan	4.0	13.0	17.2	25.5	29.1	34.8	36.8	
	E	Mixed trees	7.8	19.5	26.3	33.3	37.4	42.9	43.9	
Poniman	A	Rubber	6.1	17.9	19.3	25.3	29.0	33.6	36.6	
	B	Durian	5.4	16.2	22.8	29.8	34.8	40.1	43.4	
	C	Rambutan	7.7	19.9	25.8	31.8	36.7	41.2	44.0	
	D	Durian+Rambutan	5.4	15.5	21.7	28.0	32.5	37.7	40.6	
	E	Mixed trees	6.0	17.4	23.8	30.5	33.9	41.3	43.6	

Average	**A**	**Rubber**	**5.6**	**14.8**	**19.0**	**25.1**	**28.9**	**33.6**	**35.9**
	B	**Durian**	**5.8**	**14.9**	**19.9**	**26.8**	**30.8**	**36.0**	**38.1**
	C	**Rambutan**	**6.1**	**15.3**	**21.4**	**27.4**	**31.4**	**36.0**	**38.1**
	D	**Durian+Rambutan**	**4.8**	**13.7**	**19.4**	**25.0**	**28.7**	**33.8**	**36.3**
	E	**Mixed trees**	**5.6**	**15.0**	**21.0**	**27.3**	**31.1**	**36.7**	**38.9**

Effect of associated trees on rubber growth

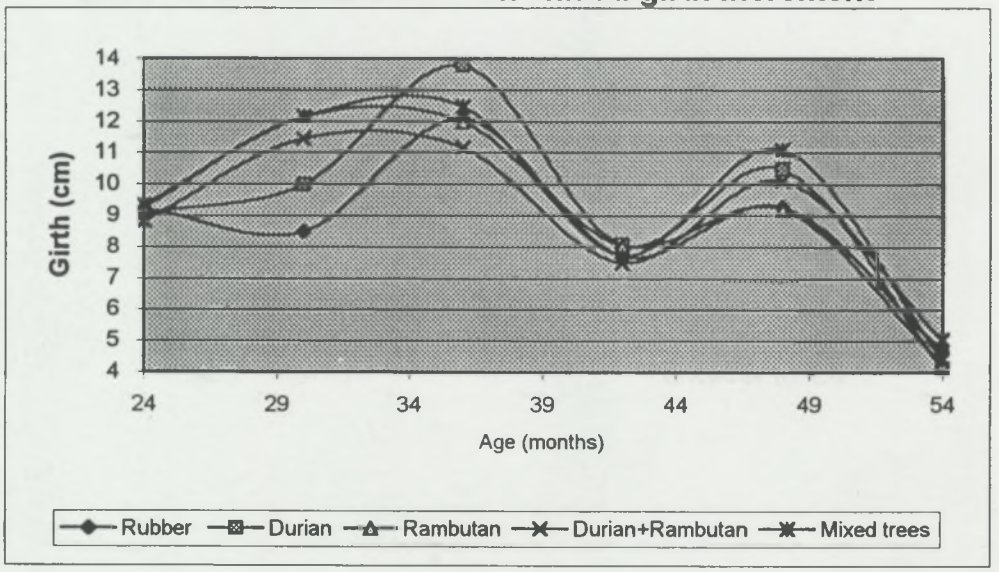


RAS 21a - WEST KALIMANTAN
Effect of fruit trees intercropping on annual rubber girth increment

Planting February 1996 - TRIMULYA

Farmer	Plot	Associated Trees	Girth (cm)						
			Feb-97	Feb-98	Aug-98	Feb-99	Aug-99	Feb-00	Aug-00
Marjo	A	Rubber		6.9	11.4	13.0	7.6	7.8	5.4
	B	Durian		5.1	9.4	14.0	7.8	10.8	3.0
	C	Rambutan		10.7	12.7	13.4	7.8	7.6	2.3
	D	Durian+Rambutan		8.5	14.6	7.6	6.6	7.9	2.5
	E	Mixed trees		7.0	10.2	11.0	6.8	10.6	4.8
Yasdi	A	Rubber		11.0	13.8	12.8	7.2	10.1	7.4
	B	Durian		10.2	12.0	12.4	7.8	8.8	4.8
	C	Rambutan		9.6	12.4	12.0	6.6	11.0	3.7
	D	Durian+Rambutan		10.1	12.4	9.6	8.2	10.2	8.9
	E	Mixed trees		11.6	13.4	13.0	8.4	10.0	4.3
Sardi	A	Rubber		10.2	12.2	10.4	8.2	8.3	4.9
	B	Durian		0.1	8.4	7.4	4.8	7.0	7.8 *(fire)*
	C	Rambutan		6.4	12.4	10.6	9.2	8.8	7.6
	D	Durian+Rambutan		0.6	10.0	8.2	7.0	8.3	5.8 *(fire)*
	E	Mixed trees		7.8	12.4	10.6	8.4	10.2	4.8
Priyo	A	Rubber		6.9	(1.4)	10.8	7.2	9.0	2.3
	B	Durian		8.7	3.1	13.5	7.6	11.5	3.9
	C	Rambutan		5.9	9.4	11.4	7.6	10.0	5.6
	D	Durian+Rambutan		6.4	9.4	9.4	6.4	10.6	4.0
	E	Mixed trees		6.5	10.4	12.8	7.8	9.9	6.1
Sadianto	A	Rubber		8.6	12.2	13.4	8.6	11.3	1.9
	B	Durian		10.5	12.2	15.0	7.2	10.6	2.2
	C	Rambutan		10.7	14.1	12.4	7.2	9.0	0.8
	D	Durian+Rambutan		9.0	8.4	16.6	7.2	11.5	4.0
	E	Mixed trees		11.7	13.6	14.0	8.2	11.0	1.9
Poniman	A	Rubber		11.8	2.8	12.0	7.4	9.1	6.1
	B	Durian		10.8	13.2	14.0	10.0	10.6	6.7
	C	Rambutan		12.2	11.8	12.0	9.8	9.0	5.6
	D	Durian+Rambutan		10.1	12.4	12.6	9.0	10.4	5.7
	E	Mixed trees		11.4	12.8	13.4	6.8	14.8	4.5
Average	**A**	**Rubber**		**9.2**	**8.5**	**12.1**	**7.7**	**9.3**	**4.7**
	B	**Durian**		**9.1**	**10.0**	**13.8**	**8.1**	**10.5**	**4.1**
	C	**Rambutan**		**9.2**	**12.1**	**12.0**	**8.0**	**9.2**	**4.3**
	D	**Durian+Rambutan**		**8.8**	**11.4**	**11.2**	**7.5**	**10.1**	**5.0**
	E	**Mixed trees**		**9.3**	**12.1**	**12.5**	**7.7**	**11.1**	**4.4**

Effect of associated trees on annual girth increment



RAS 21a - WEST KALIMANTAN
Rubber girth at 54 months
in intercropped plots

Farmer	Rubber	Durian	Rambutan	Dur+Ramb	Mixed
Marjo	33.0	30.6	37.4	32.0	30.7
Yasdi	43.4	41.0	40.1	42.0	43.4
Priyo	26.7	33.4	32.1	30.0	36.4
Sadianto	39.4	42.0	39.7	36.8	43.9
Poniman	36.6	43.4	44.0	40.6	43.6
Average	35.8	38.1	38.7	36.3	39.6

Anova: Two-Factor Without Replication

SUMMARY	*Count*	*Sum*	*Average*	*Variance*
Marjo	5	163.76	32.75	7.84
Yasdi	5	209.90	41.98	2.11
Priyo	5	158.58	31.72	13.38
Sadianto	5	201.81	40.36	7.16
Rubber	4	142.44	35.61	53.94
Durian	4	147.07	36.77	31.54
Rambutan	4	149.32	37.33	13.68
Dur+Ramb	4	140.82	35.21	28.41
Mixed	4	154.40	38.60	39.36

ANOVA

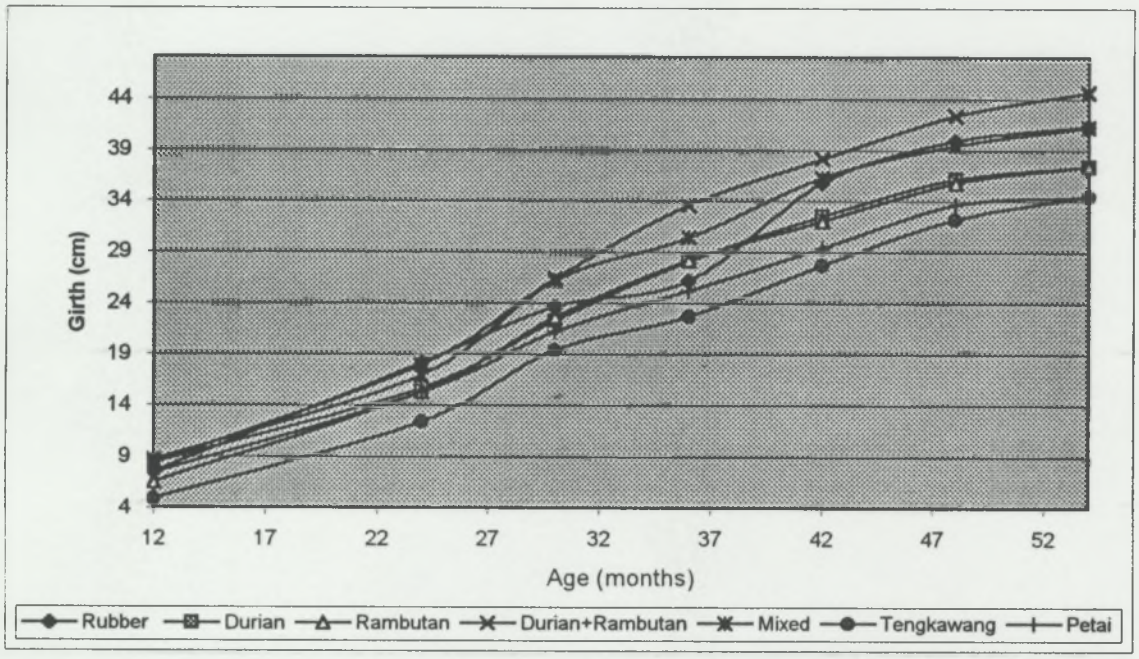
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*	
Farmer	408.58	3	136.19	17.72	0.00	3.49	**
Assoc. trees	29.74	4	7.43	0.97	0.46	3.26	
Error	92.21	12	7.68				
Total	530.52	19					

RAS 21 b - WEST KALIMANTAN
Effect of fruit trees intercropping on rubber girth

Planting February 1996 - SPP SEKADAU

Farmer	Plot	Associated Trees	Girth (cm)						
			Feb-97	Feb-98	Aug-98	Feb-99	Aug-99	Feb-00	Aug-00
SPP	A	Rubber	7.5	18.1	23.6	26.2	35.8	39.9	41.3
	B	Durian	8.4	15.7	22.3	28.1	32.5	36.2	37.4
	C	Rambutan	6.5	15.3	22.6	28.2	32.0	35.8	37.4
	D	Durian+Rambutan	8.4	17.9	26.4	33.6	38.1	42.4	44.6
	E	Mix	8.7	16.9	26.2	30.4	36.3	39.4	41.3
	F	Tengkawang	4.9	12.4	19.4	22.7	27.7	32.2	34.4
	G	Petai	7.4	15.2	21.2	25.2	29.4	33.7	34.5

Effect of associated trees on rubber growth



RAS 21 b - WEST KALIMANTAN
Effect of fruit trees intercropping on annual girth increment of rubber

Planting February 1996 - SPP SEKADAU

Farmer	Plot	Associated Trees	Girth (cm)						
			Feb-97	Feb-98	Aug-98	Feb-99	Aug-99	Feb-00	Aug-00
SPP	A	Rubber		10.6	11.0	5.2	19.2	8.3	2.7
	B	Durian		7.3	13.2	11.6	8.9	7.4	2.3
	C	Rambutan		8.8	14.6	11.2	7.6	7.6	3.2
	D	Durian+Rambutan		9.5	17.0	14.4	9.0	8.5	4.5
	E	Mix		8.2	18.6	8.4	11.8	6.3	3.6
	F	Tengkawang		7.5	13.9	6.7	10.0	9.0	4.5
	G	Petai		7.8	12.0	8.0	8.4	8.5	1.6

WEST KALIMANTAN - RAS 2.1 a

1. Trial implementation

The trial RAS 2.1a compares various fruit trees associated with rubber. The choice of species is based on farmers preference indicated prior the start of the trial. Food crops are cultivated during the first two years.

2. General observations on trial

Fruit trees have a slower growth than rubber and don't compete with rubber for light. Durian has a very slow growth and needs some shade in early development stages. Rambutan, having a rapid lateral expansion, is particularly effective to control weeds by shading.

3. Treatment analysis

- RAS 2.1 (6 replications): rubber girth at 54 months

Treatments	Girth in cm (%)
Rubber alone	35.6 (100)
Rubber with Durian	36.8 (103)
Rubber with Rambutan	37.3 (105)
Rubber with Durian & Rambutan	35.2 (99)
Rubber with Mixed trees	38.6 (108)

The association of fruit trees with rubber seems beneficial and differences in development are not statistically significant. The best results are obtained with association of rubber with rambutan. This species has a faster development than other trees and it helps the control of weeds by shading. Some rambutans are in production now and provide some income during rubber immaturity.

4. Conclusion

Association with fruit trees is beneficial to rubber because weeding requirement in the inter-row is reduced by the shading effect of fruit trees on weeds. Durian growth in early stages is rather disappointing and additional and temporary shade should be provided to durian. Bananas planted near durian could provide some shade and help early development. Rambutan is promising at 4 year old however shading from rubber trees will probably affect the production afterwards. The use of unselected fruit trees gave disappointing results except for rambutans and jackfruit trees. Grafted fruit trees with temporary shading would be more appropriate to generate some production before 5 years.

WEST KALIMANTAN - RAS 2.2
Rice intercropping and association with trees

TITLE:
Clonal rubber in agroforestry environment: rubber + selected associated trees + intercropping

OBJECTIVE/HYPOTHESE
Objectives

As in jungle rubber system where rubber seedlings are associated with various kind of trees and plants, RAS 2.2 aims to associate useful trees (fruits and timber trees) with rubber, at a limited planting density, without substantial decrease in rubber yield.
Rubber is planted at normal planting density of 550/ha as associated trees are planted at 92 trees/ha with a maximum number of 30 for big trees.

Hypotheses

- It is expected that rubber growth during immature period will not be affected by associated trees competition as these selected fruits and timber trees have generally a slow growth pattern (in particular for durian, local fruits and timber species).
- It is expected that intercropping during the first 3 or 4 years of rubber immature period will create a favorable environment for a good rubber growth due to intercrop weeding and secondary effect of fertilization.
- Intercropping will limit the extend of weeds such as Imperata.

EXPECTED OUTPUTS

To produce recommendations on components of RAS 2.2:
- weed management required for successful growth of rubber clone in this
- rice varieties and amount of fertilization (for rice oriented RAS 2.2)
- the effect of palawijas intercropping on rubber growth (for palawijas oriented RAS 2.2).
- Distribution of species for associated trees.

LOCATION: West-Kalimantan province,
Kabupaten Sanggau, Kecematan Sanggau Kapuas,

TRIAL 1 (January 1995) : 4 replications
Villages of Kopar (1 rep/95) and Engkayu (Group I = 3 rep/95) : total 4 replications for 1995 with high density of associated trees ((275 trees/ha : 6 x 6 meters)

code 1a_2295 or code "I"

TRIAL 2 (October 1993): 9 replications
Village of Sintang: 9 rep:4 rep with high density of associated trees (275 trees/ha: 6 x 6 meters) 5 rep with medium density of associated trees (135 trees/ha (6 x 9 meters)

code "sintang" : only rice yield and rubber girth every year are recorded.

TRIAL 3 (february 1996):
Village of Trimulia: 3 rep with low density of associated trees: 92 associated trees/ha.
1 trial per year of planting.

Code : 1a_2296 or cod "J"

YEAR :

Trial 1: planting of rubber : December 1994-February 1995
Trial 3: planting of rubber : December 1995-February 1996
Trial 2: planting of rubber: October 1993.

DURATION
5 to 6 years for immature period. The first 2 years are critical in terms of growth and survivability. Then, if possible, a minimum of 3 years of production monitoring.

MATERIALS AND METHOD
Treatments

Year 1
2 treatments:
Treatment 1 : rice variety : 3 variety : local, Way Rarem and Danau Tempe

Treatment 2: amount of fertilization: 0 dose, 1/2 dose, 1/1 dose (dose/ha: 100 kg urea, 140 kg SP 36 and 75 kg KCL)
Total number of plots 9 plots: 1 rep per farm.
ABPS fertilization dose is the economic dose recommended by BPS/Sembawa.

FERTILIZATION DOSE

Dose in kg/ha	Urea	SP 36	KCl
BPS	100	160	75

Urea is supplied in 3 times: 1/3 at planting time, 1/3 1 month after planting and 1/3 2 months after planting.

EXPERIMENTAL DESIGN
Split-plot with main treatment on rice variety and sub-treatment on fertilization December 1995-February 1996.

Year 2 and 3

2 treatments:
Treatment 1 : rice variety : 3 variety : local, Way Rarem and Danau Tempe or Jatiluhur with fertilization.
Treatment 2 : fertilization : 3 levels :
Amount of fertilization:
- 0 dose
- BPS dose
- CRIFC dose

ABPS fertilization dose is the economic dose recommended by BPS/Sembawa.
FERTILIZATION DOSE

Dose in kg/ha	Urea	SP 36	KCl
BPS	100	160	75

ACRIFC fertilization dose is the dose recommended by CRIFC/Bogor.

FERTILIZATION DOSE

Dose in kg/ha	Urea	SP 36	KCL
CRIFC	150	220	150

Urea is supplied in 3 times: 1/3 at planting time, 1/3 1 month after planting and 1/3 2 months after planting.

Total number of plots 3 (1 rice variety) or 6 plots (2 rice varieties) : 1 rep per farm. 1 extra plot may be kept for local rice.

In case of alang2 invasion

If the field is invaded by imperata : it is recommended to plant in the interrow, every 6 meters, Gmelina : a fast growing pulp trees for shading. Gmelina is harvested the 7th year pulp.
In case of rice failure or change in farmers strategy (abandon of intercropping), the field should be planted with a non viny covercrops to protect the field against Imperata: with Flemingia. (case of Gabriel's plot in Engkayu in 1996).

EXPERIMENTAL DESIGN

Randomized block design with1 rice variety.
Split plot: with 2 rice varieties.

RUBBER

All rep are planted with clones (PB 260 or RRIC 100). Clone is not considered as a treatment as they have a similar growth pattern.

FERTILIZATION

TCSDP fertilization program for NPK for the first 2 years. No fertilization later.
TCSDP fertilization program is the following:

In g/tree

	Planting time October 96	+ 3 months January 97	+ 6 months April	+ 9 months July	+ 12 months October
RP	200				
Urea		50	50	50	50
SP36		40	40	40	40
KCl			40	40	40

Rubber planting distance

Standard: 550 trees/ha : 3 x 6 meters.

Rubber weeding :

6 weeding a year , every 2 months, on a regular basis.

INTERCROPPING

In dry season : possibility of growing groundnut (in particular in Trimulia) or other palawija (except banana and cassava).

ASSOCIATED TREES

Planting density : 92 trees/ha : 9 x 12 meters.
No fertillization.
Weeding : same as for rubber (6 weedings/year).
Proposed tree distribution (should be according to farmers requirement and/or markets) :

- Durian local (or pekawai) 20 %
- Rambutan (or duku) 20 %
- Petai 20 %
- Jengkol (or tangkill) 20 %
- miscellanous 20 %

(keladan, nyatoh, meranti, tengkawang , other fruit trees such as nangka, cempedak, mango...)

Except in Trial 2 : 5 rep in Sintang called "High density of associated trees" with 275 trees/ha.

FIELD SIZE

Year 1
PLOT SIZE for rubber + intercropping: 500 m2
NUMBER OF PLOTS PER farm: 9 plots
REPLICATION/FARM SIZE: 4500 m2
NUMBER OF REPLICATION per farm: 1
Number of plots per replication: 9 plots

Year 2
PLOT SIZE for rubber + intercropping: 500 m2
NUMBER OF PLOTS PER farm: 9 plots
REPLICATION/FARM SIZE: 4500 m2
NUMBER OF REPLICATION per farm: 1
Number of plots per replication: 3 plots

Some farms (Kopar/Engkayu)have only 4 plots of 1000 m5 : 3 plots with 1 rice variety and 3 fertilization levels and 1 plot with local rice.

DATA TO BE COLLECTED

Standard data for all RAS 2.2:

RUBBER

- rubber growth measurements : diameter, height and whorls the first year every 3 months. Then girth the second year every 3 months. Sample of 30 trees per plot.

ASSOCIATED TREES

- tree growth measurements : girth every year at planting anniversary time for all trees per plot.

RICE

- date of planting
- date of harvest
- yield of 100 m2 square at 14 % water content

PALAWIJA (if any in dry season)

- distribution of crops and average planting density
- date of planting for each crop
- date of harvest for each crop
- yield of 100 m2 square for banana and cassava.
- distribution between self-consumption and sales

- Farmer's labor for each plot.
- soil samples per replication on 0-5 and 5-20 cm. Before planting.

for RAS 2 and 3
for Kopar/Engggayu kelompok 1, Trimulia

WEEDING LEVEL number of weeding per year year 1 and 2	WEEDING LEVEL Number of weeding per year year 3	TYPE OF WEEDING in the rubber row
6 X	4x	n° 1 round-up N° 2 manual N° 3 round-up N° 4 manual

The new weeding regime begins in January 1998

for Kopar/Engggayu kelompok 2, Trimulia,

WEEDING LEVEL number of weeding per year year 1	WEEDING LEVEL Number of weeding per year year 2	TYPE OF WEEDING in the rubber row
6 X	4x	n° 1 round-up N° 2 manual N° 3 round-up N° 4 manual

The new weeding regime begins in January 1998

For all RAS 2 and 3 plots : 4 weeding per year beginning in January 1998.

If no Alang2: round-up is replaced by Gramoxone.

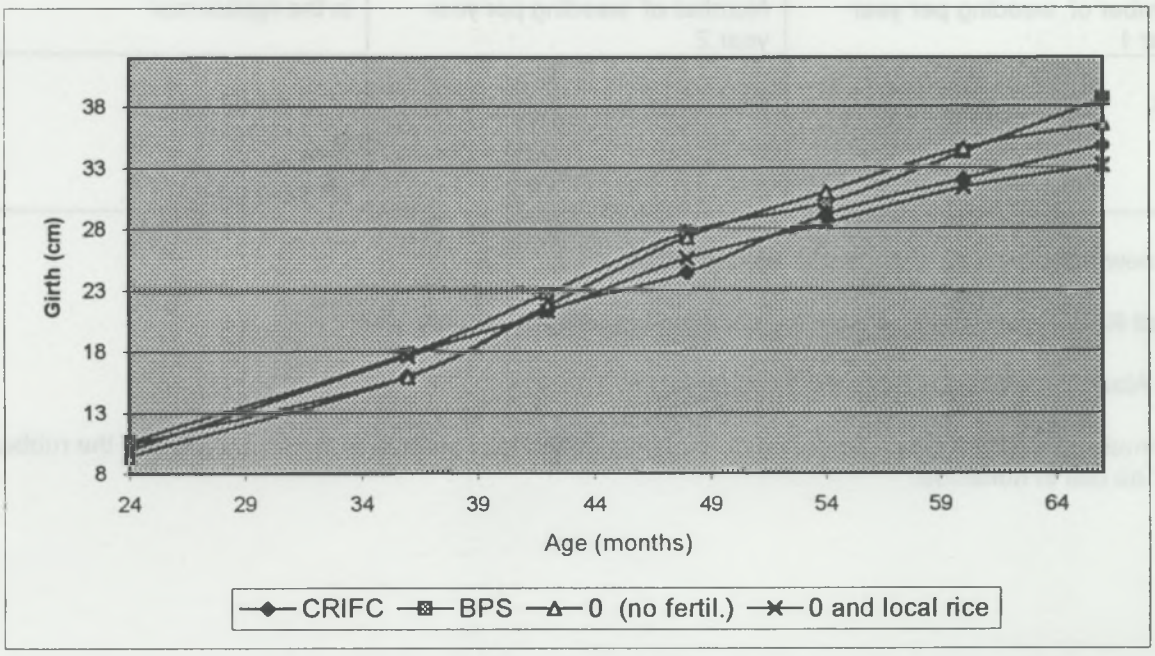
In Trimulia and SPP Karya : if there is intercropping on the total surface of the field, including the rubber row : no use of herbicide. `

RAS 22 a - WEST KALIMANTAN
Residual effect of rice cultivation on rubber girth

Planting: February 1995 - Kopar 1 -Engkayu 1

Farmer	Plot	Fertilization scheme for upland rice	Girth (cm)						
			Feb-97	Feb-98	Aug-98	Feb-99	Aug-99	Feb-00	Aug-00
Andreas	A	CRIFC	13.2	20.6	26.0	27.3	34.4	36.9	39.6
	B	BPS	12.8	22.1	26.9	31.8	33.9	37.1	38.7
	C	0 (no fertil.)	15.0	23.4	29.8	35.2	38.0	39.5	40.9
	D	0 and local rice	12.1	22.1	27.9	33.6	37.1	39.6	40.1
Muksin	A	CRIFC	9.0	15.2	19.4	23.2	29.2	30.8	31.9
	B	BPS	8.6	15.8	18.2	26.4	28.3	32.6	36.3
	C	0 (no fertil.)	6.3	12.8	19.6	25.8	29.7	33.7	35.6
	D	0 and local rice	5.8	12.0	12.7	14.4	15.7	16.7	17.9
Garmin	A	CRIFC	7.6	13.0	20.2	23.8	27.3	30.8	34.3
	B	BPS	8.0	13.9	22.7	24.8	27.5	32.6	35.8
	C	0 (no fertil.)	5.8	11.7	17.4	23.8	27.5	31.2	34.3
	D	0 and local rice	9.0	14.9	21.8	27.0	30.0	33.7	37.0
Gabriel 2	A	CRIFC	11.6	15.1	19.8	23.4	25.5	29.6	33.2
	B	BPS	12.8	19.5	23.1	27.8	30.8	34.7	43.3
	C	0 (no fertil.)	10.6	15.8	20.2	24.1	28.6	33.7	35.5
	D	0 and local rice	12.9	21.4	22.7	27.3	30.8	35.5	37.5
Average	**A**	**CRIFC**	**10.4**	**16.0**	**21.3**	**24.4**	**29.1**	**32.0**	**34.7**
	B	**BPS**	**10.6**	**17.8**	**22.7**	**27.7**	**30.1**	**34.2**	**38.5**
	C	**0 (no fertil.)**	**9.4**	**15.9**	**21.7**	**27.2**	**31.0**	**34.5**	**36.5**
	D	**0 and local rice**	**10.0**	**17.6**	**21.3**	**25.6**	**28.4**	**31.4**	**33.1**

Effect of upland rice cultivation on rubber growth



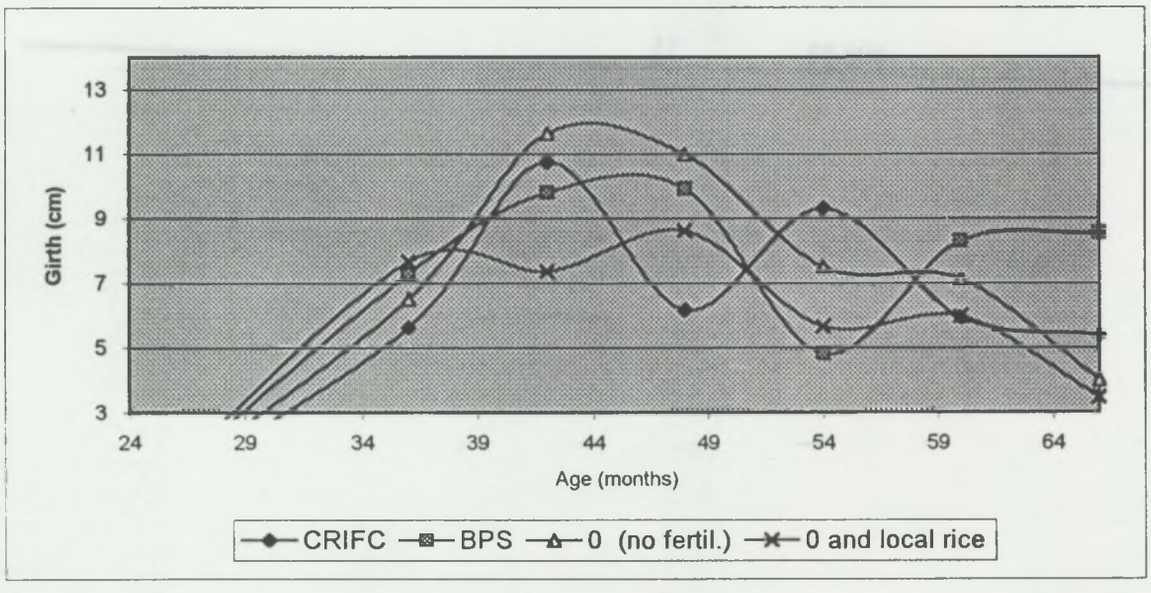
RAS 22 a - WEST KALIMANTAN
Residual effect of rice cultivation on annual girth increment of rubber

Planting: February 1995 - KOPAR-ENGKAYU

Farmer	Plot	Fertilization scheme for upland rice	Annual girth increment (cm)					
			Feb-97	Feb-98	Aug-98	Feb-99	Aug-99	Feb-00	Aug-00
Andreas	A	CRIFC	7.4	10.7	2.6	14.2	5.1	5.3
	B	BPS	9.3	9.5	9.9	4.1	6.6	3.1
	C	0 (no fertil.)	8.4	12.8	10.8	5.6	2.9	2.8
	D	0 and local rice	10.0	11.6	11.5	7.0	5.0	0.9
Muksin	A	CRIFC	6.2	8.5	7.5	12.0	3.3	2.1
	B	BPS	7.2	4.8	16.3	3.8	8.6	7.3
	C	0 (no fertil.)	6.5	13.6	12.5	7.8	8.1	3.6
	D	0 and local rice	6.2	1.3	3.3	2.7	1.9	2.5
Garmin	A	CRIFC	5.4	14.4	7.3	6.9	7.1	7.0
	B	BPS	5.9	17.6	4.2	5.3	10.3	6.5
	C	0 (no fertil.)	5.9	11.4	12.8	7.5	7.4	6.0
	D	0 and local rice	5.9	13.8	10.4	5.9	7.5	6.5
Gabriel 2	A	CRIFC	3.5	9.3	7.2	4.2	8.2	7.1
	B	BPS	6.7	7.3	9.3	6.0	7.7	17.3
	C	0 (no fertil.)	5.3	8.7	7.9	9.0	10.1	3.6
	D	0 and local rice	8.5	2.7	9.2	7.0	9.5	3.9

Average	**A**	**CRIFC**	**5.6**	**10.7**	**6.2**	**9.3**	**5.9**	**5.4**
	B	**BPS**	**7.3**	**9.8**	**9.9**	**4.8**	**8.3**	**8.6**
	C	**0 (no fertil.)**	**6.5**	**11.6**	**11.0**	**7.5**	**7.1**	**4.0**
	D	**0 and local rice**	**7.6**	**7.3**	**8.6**	**5.7**	**6.0**	**3.5**

Effect of upland rice cultivation on annual girth increment



RAS 22 a - WEST KALIMANTAN
Rubber girth at 66 months
in upland rice intercropped plots

	Different fertilizer schemes on upland rice			
Farmer	CRIFC	BPS	0 (no fertil.)	0 & local rice
Andreas	34.4	33.9	38.0	37.1
Muksin	29.2	28.3	29.7	15.7
Garmin	27.3	27.5	27.5	30.0
Gabriel 2	25.5	30.8	28.6	30.8
Average	29.1	30.1	31.0	28.4

Anova: Two-Factor Without Replication

SUMMARY	*Count*	*Sum*	*Average*	*Variance*
Andreas	4	143.39	35.85	4.15
Muksin	4	102.84	25.71	44.88
Garmin	4	112.23	28.06	1.64
Gabriel 2	4	115.70	28.93	6.29
CRIFC	4	116.32	29.08	14.77
BPS	4	120.39	30.10	8.32
0 (no fertil.)	4	123.88	30.97	22.99
0 & local rice	4	113.57	28.39	81.73

ANOVA

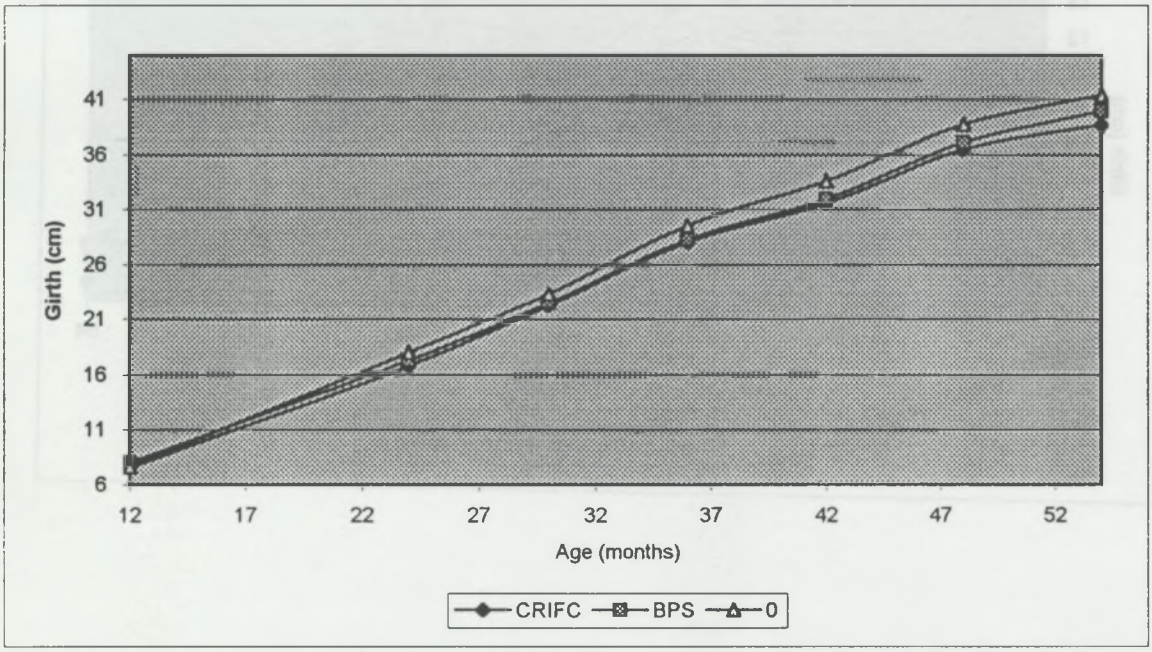
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*	
Farmer	227.97	3	75.99	4.40	0.036	3.86	*
Fertilizer scheme	15.39	3	5.13	0.30	0.827	3.86	
Error	155.47	9	17.27				
Total	398.83	15					

RAS 22 b - WEST KALIMANTAN
Residual effect of rice cultivation on rubber girth

Planting February 1996 TRIMULYA

Farmer	Plot	Fertilization scheme for upland rice	Girth (cm) Feb-97	Feb-98	Aug-98	Feb-99	Aug-99	Feb-00	Aug-00	
Raji	A	CRIFC	9.5	17.1	21.8	28.4	32.1	36.74	39.71	
	C	BPS	8.4	15.2	19.8	25.8	29.0	33.06	36.42	
	E	0	7.7	16.8	20.5	28.4	31.6	35.76	38.26	
Ponimin	A	CRIFC	4.9	14.1	20.6	26.5	29.9	34.53	36.75	
	C	BPS	-	4.4	9.2	12.6	15.4	18.87	22.31	*(fire)*
	E	0	5.3	15.7	22.6	28.2	32.5	38.02	40.99	
Suwito	A	CRIFC	8.1	19.1	24.4	29.3	32.6	38.06	39.66	
	C	BPS	7.6	19.4	25.2	30.8	34.9	41.19	43.38	
	E	0	9.9	21.5	26.8	32.1	36.7	42.45	44.90	
Average	**A**	**CRIFC**	**7.5**	**16.7**	**22.2**	**28.0**	**31.5**	**36.4**	**38.7**	
	C	**BPS**	**8.0**	**17.3**	**22.5**	**28.3**	**31.9**	**37.1**	**39.9**	
	E	**0**	**7.6**	**18.0**	**23.3**	**29.5**	**33.6**	**38.7**	**41.4**	

Effect of upland rice cultivation on rubber growth

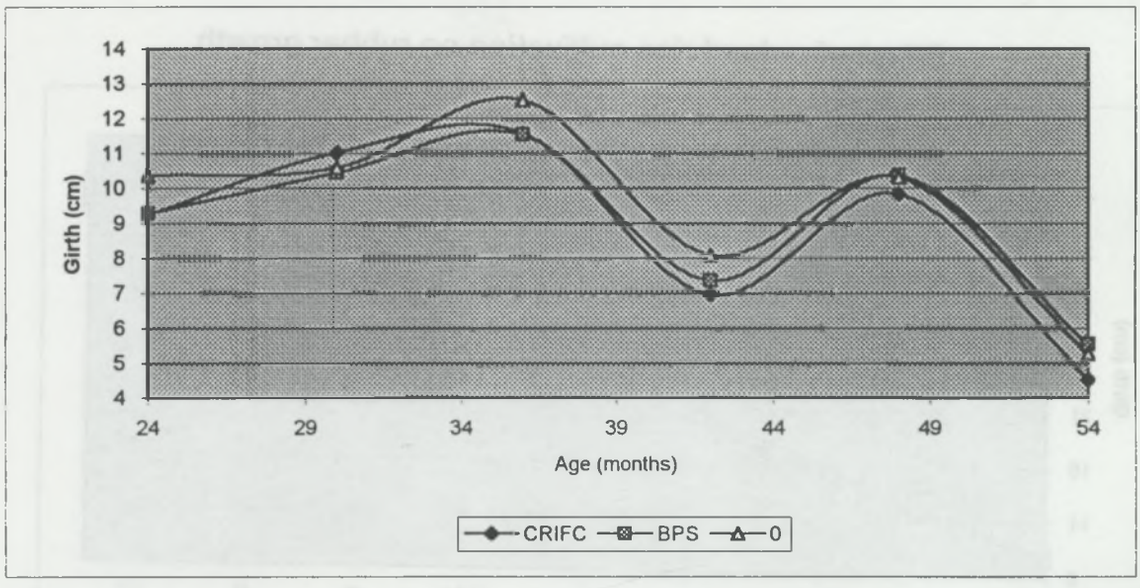


RAS 22 b - WEST KALIMANTAN
Residual effect of rice cultivation on annual girth increment of rubber

Planting February 1996 TRIMULYA

Farmer	Plot	Fertilization scheme for upland rice	Girth (cm)						
			Feb-97	Feb-98	Aug-98	Feb-99	Aug-99	Feb-00	Aug-00
Raji	A	CRIFC		7.6	9.3	13.2	7.5	9.3	5.9
	C	BPS		6.8	9.2	12.0	6.5	8.2	6.7
	E	0		9.1	7.3	15.8	6.4	8.4	5.0
Ponimin	A	CRIFC		9.2	13.1	11.7	6.9	9.3	4.4
	C	BPS		4.4	9.6	6.7	5.7	6.9	6.9 *(fire)*
	E	0		10.4	13.8	11.1	8.6	11.1	5.9
Suwito	A	CRIFC		11.0	10.6	9.9	6.5	11.0	3.2
	C	BPS		11.8	11.7	11.0	8.3	12.6	4.4
	E	0		11.6	10.6	10.6	9.3	11.4	4.9
Average	**A**	**CRIFC**		**9.2**	**11.0**	**11.6**	**7.0**	**9.8**	**4.5**
	C	**BPS**		**9.3**	**10.4**	**11.5**	**7.4**	**10.4**	**5.6**
	E	**0**		**10.4**	**10.6**	**12.5**	**8.1**	**10.3**	**5.3**

Effect of upland rice cultivation on rubber growth



WEST KALIMANTAN - RAS 2.2 a &b

1. Trial implementation

The trials RAS 2.2 a and b compare different fertilizer schemes applied on upland rice. The aim of the trials is to investigate the possibilities to increase income for rice intercropping and at the same time to maintain a fast rubber growth thanks to weeding provided for rice cultivation. In Ponimin's farm, an accidental fire damaged rubber trees in a plot.

2. General observations on trial

Rice was cultivated twice but yields were widely variable mostly because of pest incidence. Rubber clones performed satisfactorily with an average girth increment of 9cm/year up to 48 months then growth decreases because of competition between trees and some well-developed fruit trees (rambutan). At 5.5 years some trees have reached tapping size standard.

3. Treatment analysis

- RAS 2.2a (4 replications)

Girth at 66 months

Treatments	Girth in cm (%)
Rice with CRIFC dose	33.7 (100)
Rice with BPS dose	38.5 (114)
Rice without fertilizer	36.5 (108)
Local rice without fertilizer	33.1 (98)

Fertilization has no clear effect on rubber development and there is no residual effect of fertilizer on rubber.

- RAS 2.2b (3 replications):

Girth at 54 months

Treatments	Girth in cm (%)
Rice with CRIFC dose	38.7 (100)
Rice with BPS dose	39.9 (103)
Rice without fertilizer	41.4 (107)

As in RAS 2.2b fertilization on rice has no effect on rubber growth

4. Conclusion

Rice cultivation doesn't affect rubber growth and the association with rubber is beneficial in terms of weeding costs. In the trials, there were no residual effects on rubber growth by fertilizer applied on upland rice. In some cases, a few well-developed fruit trees compete with rubber.

WEST KALIMANTAN - RAS 3.1
Various types of cover crops

TITLE:
Clonal rubber in agroforestry environment: rubber + selected associated trees + intercropping (first year) + covercrops. **Experimentation on covercrops.**

OBJECTIVE/HYPOTHESE
Objectives

RAS 3.1 aims to associate useful trees (fruits and timber trees) with rubber, at a limited planting density, without substantial decrease in rubber yield.
Rice is intercropped in the first year at planting time, immediately followed by covercrops in the interrows. Covercrops should not be competitive with rubber. Non viny covercrops have been chosen to limit weeding. The objective of this trial is to identify the best combination of covercrops (Mucuna, Crotalaria, Flemingia, LCC...), MPT (Gliricidia, Chromolena; Sesbania, Wingbean, pigeon-pea..) and FGT (Gmelina). to protect the soil, overcome Imperata and ensure the best rubber and associated trees growth.

Rubber is planted at normal planting density of 550 trees/ha as associated trees are planted at 92 trees/ha with a maximum number of 30 big trees/ha.
RAS 3 has the same frame (rubber + associated trees) as RAS 2

Hypotheses

General to RAS 3:
- It is expected that rubber growth during immature period will not be affected by associated trees competition as these selected fruits and timber trees have generally a slow growth pattern (in particular for durian, local fruits and timber species).

Specific to RAS 3.1:
- farmers do not want to grow annual intercrops. Covercrops should protect the inter-row during rubber immature period and limit Imperata.
- non viny covercrops limits weeding and labor requirement compared to traditional viny LCC used in TCSDP technology.

EXPECTED OUTPUTS

To produce recommendations on components of RAS 3 concerning covercrops:
- species of covercrops adapted to local conditions.

LOCATION: West-Kalimantan province,
Kabupaten Sanggau, Kecamatan Sanggau Kapuas,

TRIAL: Village of Kopar: 1 rep/95 as an observation plot.

code 1a_3195 or code "K"

YEAR: Planting of rubber: December 1994-February 1995

DURATION
The first year is critical for covercrops establishment.
5 to 6 years for immature period. The first 2 years are critical in terms of growth and survivability. Then, if possible, a minimum of 3 years of production monitoring.

MATERIALS AND METHOD

Treatments

Year 1:
Local rice variety (September-February)
February/March : covercrops establishment.

Treatments: 5 types of covercrops:
A Control: LCC.
B Flemingia
C Chromolena
D Flemingia + Gliricidia (1.5 x 1.5 m)
E Kecipir.

Total number of plots: 5 plots: 1 rep/ farm only.

FIELD DESIGN IN 1995/1996/97

MUCUNA	SETARIA	CHROMOLENA In polybag In cuttings	FLEMINGIA + GLIRICIDIA	FLEMINGIA + KECIPIR

EXPERIMENTAL DESIGN
Randomized block design.

RUBBER

Clone: BPM 1.

FERTILIZATION
TCSDP fertilization program for NPK for the first 2 years. No fertilization later.

Rubber planting distance
Standard: 550 trees/ha: 3 x 6 meters.

Rubber weeding :

6 weeding a year, every 2 months, on a regular basis for the first 2 years.
Year 3, 4 and 5: 3 weeding/year on the row.

INTERCROPPING

No, after the year 1

ASSOCIATED TREES

Planting density: 92 trees/ha : 9 x 12 meters.
No fertilization.
Weeding: same as for rubber (6 weeding/year).

FIELD SIZE

PLOT SIZE: 1000 m2
NUMBER OF PLOTS PER farm: 5 plots
REPLICATION/FARM SIZE: 5 000 m2
NUMBER OF REPLICATION/farm: 1

DATA TO BE COLLECTED

- Standard data for all RAS 3 (similar to RAS 2):

RUBBER

- Rubber growth measurements: diameter, height and whorls the first year every 3 months. Then girth the second year every 3 months. Sample of 30 trees per plot.

ASSOCIATED TREES

- tree growth measurements : girth every year at planting anniversary time for all trees per plot.

RICE

- date of planting
- date of harvest
- yield of 100 m2 square at 14 % water content

COVERCROPS

This trial with only 1 replication may be considered as an observation plot where several various combinations are tried every year.

WEST KALIMANTAN - RAS 3.2
Various types of cover crops and shrubs

TITLE:
Clonal rubber in agroforestry environment: rubber + selected associated trees + intercropping (first year) + covercrops. **Experimentation on covercrops.**

OBJECTIVE/HYPOTHESE
Objectives

RAS 3.2 is an extrapolation of RAS 3.1 with 5 replications. RAS 3.2 aims to associate useful trees (fruits and timber trees) with rubber, at a limited planting density, without substantial decrease in rubber yield. Rice is intercropped in the first year at planting time, immediately followed by covercrops in the interrows. Covercrops should not be competitive with rubber. Non viny covercrops have been chosen to limit weeding. The objective of this trial is to identify the best combination of covercrops (Mucuna, Crotalaria, Flemingia, LCC...), MPT (Gliricidia, Chromolaena; Sesbania, Wingbean, pigeon-pea..) and FGT (Gmelina). to protect the soil, overcome Imperata and ensure the best rubber and associated trees growth.

Rubber is planted at normal planting density of 550 trees/ha as associated trees are planted at 92 trees/ha with a maximum number of 30 big trees/ha.
RAS 3 has the same frame (rubber + associated trees) as RAS 2

Hypotheses

General to RAS 3:
- It is expected that rubber growth during immature period will not be affected by associated trees competition as these selected fruits and timber trees have generally a slow growth pattern (in particular for durian , local fruits and timber species).

Specific to RAS 3.2 (similar to RAS 3.1):
- farmers do not want to grow annual intercrops. Covercrops should protect the inter-row during rubber immature period and limit Imperata.
- non viny covercrops limits weeding and labor requirement compared to traditional viny LCC used in TCSDP technology.

EXPECTED OUTPUTS

To produce recommendations on components of RAS 3 concerning covercrops:
- Species of covercrops adapted to local conditions.

LOCATION: West-Kalimantan province,
Kabupaten Sanggau, Kecamatan Sanggau Kapuas,
TRIAL: code 1a_3296 or code "M"
Village of Kopar: 5 rep planted in October 1996.

YEAR of planting:
Planting of rubber: October/December1996

DURATION

The first year is critical for covercrops establishment.
5 to 6 years for immature period. The first 2 years are critical in terms of growth and survivability. Then, if possible, a minimum of 3 years of production monitoring.

MATERIALS AND METHOD
Treatments

Year 1 :
Local rice variety (September 96-february97)
February/March 1997: covercrops establishment.

Treatments: 6 types of covercrops :
A Control n 1: LCC + rubber only.
B Control n 2: Imperata + rubber only
C Flemingia + Gliricidia (1.5 x 2 m)+ Gmelina (6 x 3m)
D Chromolaena in cuttings (0.5 x 0.5 meters)
E Crotalaria (orok2) + Gliricidia (1.5 x 2 m) + Gmelina (6 x 3 m)
F Mucuna + pigeon pea (1 x 1 meter)

Total number of plots: 6 plots/rep: 1 rep/ farm only.

RAS 3 in Kopar
1 field has 6 plots

TCSDP like karet + LCC control n 1	Mucuna + pigeon pea	Flemingia + Gliricidia + Gmelina	Orok 2 + Gliricidia + Gmelina	chromolena + Gmelina	imperata control n 2

EXPERIMENTAL DESIGN
Randomized block design.

RUBBER
Clone: PB 260.
FERTILIZATION
TCSDP fertilization program for NPK for the first 2 years including CA (Calcium). No fertilization later.

In g/tree	Planting time	+ 3 months	+ 6 months	+ 9 months	+ 12 months
CA	40	40	40	40	
Urea		50	50	50	50
SP36	540	40	40	40	40
KCL			25	25	25
In kg.ha	planting time	+ 3 months	+ 6 months	+ 9 months	+ 12 months
CA in kg/ha	22	22	22	22	
Urea kg/ha		28	28	28	28
SP36 kg/ha	300	22	22	22	22
KCl kg/ha			14	14	14

RUBBER PLANTING DISTANCE
Standard: 550 trees/ha: 3 x 6 meters.

Rubber weeding:

6 weeding a year, every 2 months, on a regular basis.
Year 3, 4 and 5: 3 weeding/year on the row.

INTERCROPPING
No, after the year 1

ASSOCIATED TREES

Planting density : 92 trees/ha : 9 x 12 meters.
No fertilization.
Weeding : same as for rubber (6 weeding/year).

FIELD SIZE

PLOT SIZE: 1000 m2
NUMBER OF PLOTS PER FARM: 6 plots
REPLICATION/FARM SIZE: 6 000 m2
NUMBER OF REPLICATION/farm: 5
Total area of the trial: 3 ha.

DATA TO BE COLLECTED

- Standard data for all RAS 3 (similar to RAS 2):

RUBBER
- Rubber growth measurements: diameter, height and whorls the first year every 3 months. Then girth the second year every 3 months. Sample of 30 trees per plot.

ASSOCIATED TREES
- Tree growth measurements: girth every year at planting anniversary time for all trees per plot.

RICE
- date of planting
- date of harvest
- yield of 100 m2 square at 14 % water content

COVERCROPS

Control of growth and ground cover.

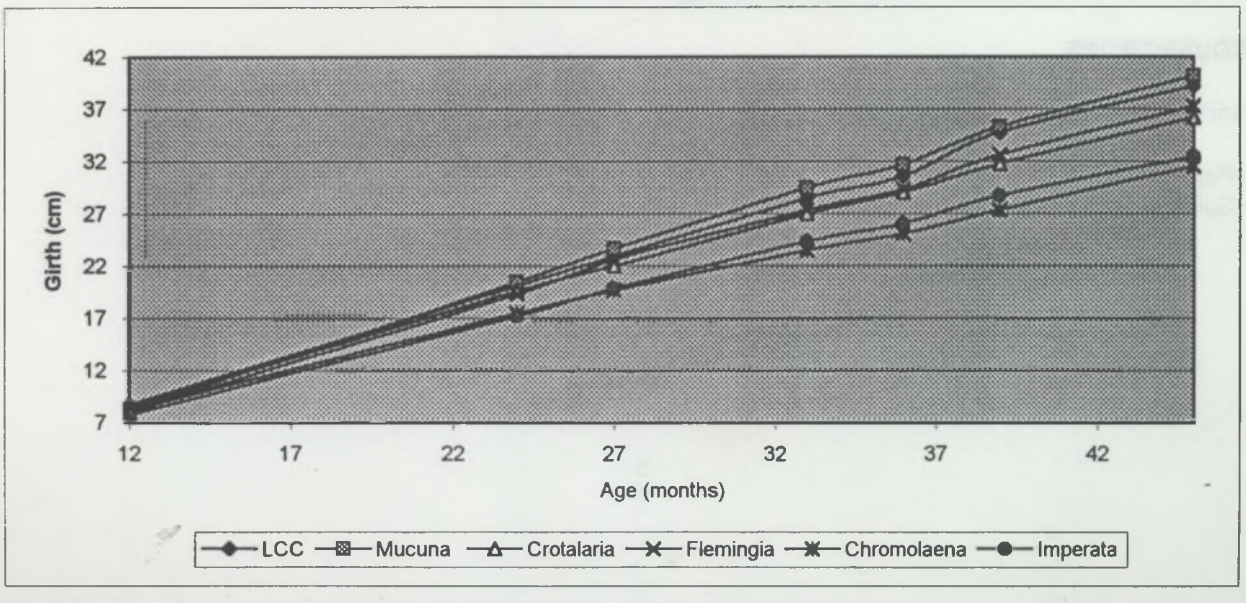
- Farmer's labor for each plot.
- Soil samples per replication on 0-10 and 10-20 cm.

RAS 32 a - WEST KALIMANTAN
Effect of various cover crops on rubber girth

Planting November 1996 Kopar 2

Farmer	Plot	Various cover crops	Girth (cm)						
			Nov-97	Nov-98	Feb-99	Aug-99	Nov-99	Feb-00	Aug-00
Akut	A	LCC	9.6	20.4	24.1	30.0	32.3	37.06	41.52
	B	*Mucuna cochensinensis*	9.5	23.0	27.2	32.2	35.3	39.51	44.25
	C	*Crotalaria anagyroides*	10.1	22.8	26.8	32.6	34.6	37.71	41.51
	D	*Flemingia macrophylla*	9.1	20.4	23.1	28.7	30.8	33.84	37.95
	E	*Chromolaena odorata*	9.4	18.3	20.8	25.1	27.2	29.74	33.54
	F	*Imperata cylindrica*	10.1	21.7	24.7	29.8	31.8	34.78	37.67
Kimbon	A	LCC	8.1	19.9	22.0	27.8	29.8	34.43	38.81
	B	*Mucuna cochensinensis*	6.6	17.0	20.0	26.6	28.7	32.52	38.81
	C	*Crotalaria anagyroides*	5.8	13.3	15.4	19.1	20.9	22.78	28.04
	D	*Flemingia macrophylla*	6.9	14.7	17.6	21.7	23.4	26.47	31.88
	E	*Chromolaena odorata*	6.5	13.5	15.1	18.6	20.4	22.38	27.84
	F	*Imperata cylindrica*	4.9	10.1	11.8	16.7	18.2	19.91	24.46
Kolanus	A	LCC	8.5	19.8	23.0	29.2	31.9	35.17	40.23
	B	*Mucuna cochensinensis*	7.2	18.6	21.4	28.8	30.4	34.04	38.81
	C	*Crotalaria anagyroides*	9.0	19.5	22.1	27.6	29.5	32.88	38.33
	D	*Flemingia macrophylla*	6.1	17.7	22.9	27.9	29.9	33.55	39.05
	E	*Chromolaena odorata*	7.8	17.6	19.4	24.2	26.3	29.39	34.91
	F	*Imperata cylindrica*	8.3	17.9	20.9	26.7	29.1	32.56	38.07
Rasyid	A	LCC	8.4	19.8	23.0	28.5	30.6	35.26	39.89
	B	*Mucuna cochensinensis*	7.5	18.4	21.1	25.6	28.1	30.44	35.33
	C	*Crotalaria anagyroides*	7.0	16.7	19.1	21.5	23.8	25.76	28.28
	D	*Flemingia macrophylla*	7.6	18.7	22.0	25.9	27.8	31.07	35.64
	E	*Chromolaena odorata*	6.8	14.1	15.8	18.4	18.7	19.57	21.38
	F	*Imperata cylindrica*	4.8	11.8	14.4	16.7	17.3	18.35	20.47
Yohanes	A	LCC	8.9	20.6	22.6	26.8	28.4	31.75	35.36
	B	*Mucuna cochensinensis*	9.6	25.3	28.6	34.2	35.9	39.83	43.70
	C	*Crotalaria anagyroides*	10.4	25.9	26.7	34.2	36.2	39.59	44.53
	D	*Flemingia macrophylla*	10.1	25.0	27.4	32.6	34.7	38.12	41.86
	E	*Chromolaena odorata*	10.2	24.2	27.2	31.0	32.8	35.86	39.74
	F	*Imperata cylindrica*	10.7	24.6	27.6	31.9	33.9	37.88	41.40
Average	**A**	**LCC**	**8.7**	**20.1**	**23.0**	**28.5**	**30.6**	**34.7**	**39.2**
	B	***Mucuna cochensinensis***	**8.1**	**20.5**	**23.7**	**29.5**	**31.7**	**35.3**	**40.2**
	C	***Crotalaria anagyroides***	**8.5**	**19.6**	**22.0**	**27.0**	**29.0**	**31.7**	**36.1**
	D	***Flemingia macrophylla***	**8.0**	**19.3**	**22.6**	**27.4**	**29.3**	**32.6**	**37.3**
	E	***Chromolaena odorata***	**8.1**	**17.5**	**19.7**	**23.5**	**25.1**	**27.4**	**31.5**
	F	***Imperata cylindrica***	**7.8**	**17.2**	**19.9**	**24.4**	**26.1**	**28.7**	**32.4**

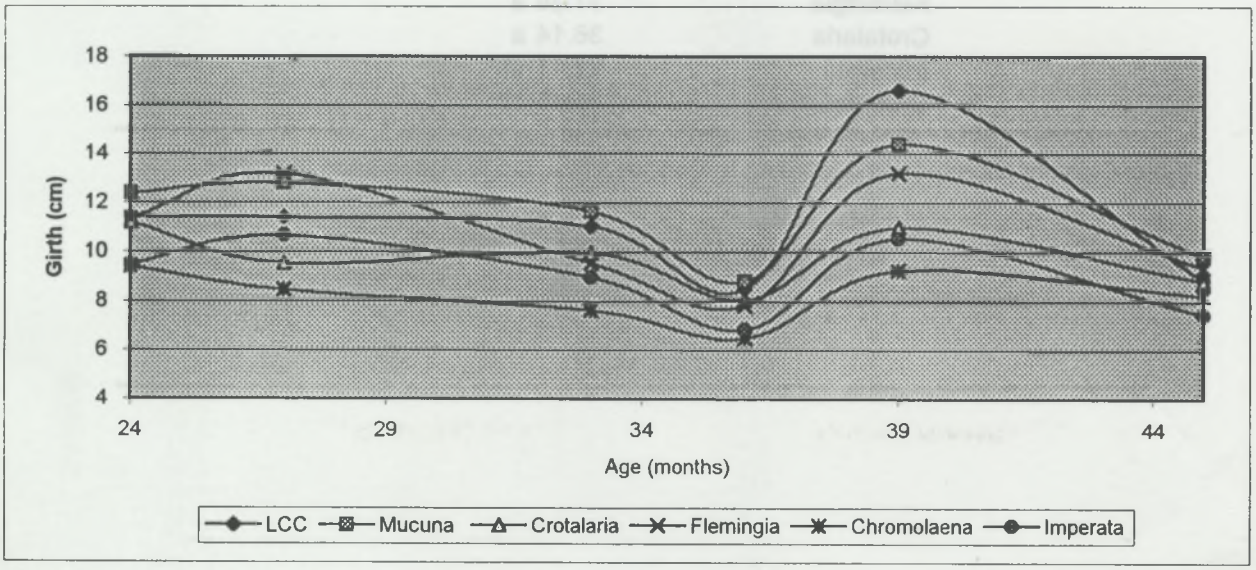
Effect of cover crops on rubber growth



RAS 32 a - WEST KALIMANTAN
Effect of various cover crops on annual girth increment

Planting November 1996 Kopar 2

Farmer	Plot	Various cover crops	Girth (cm)					
			Nov-97	Nov-98	Feb-99	Aug-99	Nov-99	Feb-00	Aug-00
Akut	A	LCC	10.8	14.8	11.8	9.2	19.0	8.9
	B	*Mucuna cochensinensis*	13.5	16.8	10.0	12.4	16.9	9.5
	C	*Crotalaria anagyroides*	12.7	16.0	11.6	8.0	12.4	7.6
	D	*Flemingia macrophylla*	11.3	10.8	11.2	8.3	12.3	8.2
	E	*Chromolaena odorata*	8.9	10.0	8.6	8.5	10.1	7.6
	F	*Imperata cylindrica*	11.6	12.1	10.2	7.9	12.0	5.8
Kimbon	A	LCC	11.8	8.5	11.5	8.1	18.4	8.8
	B	*Mucuna cochensinensis*	10.4	12.0	13.2	8.4	15.3	12.6
	C	*Crotalaria anagyroides*	7.5	8.4	7.3	7.4	7.6	10.5
	D	*Flemingia macrophylla*	7.8	11.6	8.2	6.7	12.4	10.8
	E	*Chromolaena odorata*	7.0	6.2	7.1	7.3	7.8	10.9
	F	*Imperata cylindrica*	5.2	6.8	9.8	6.0	6.8	9.1
Kolanus	A	LCC	11.3	12.8	12.4	10.6	13.3	10.1
	B	*Mucuna cochensinensis*	11.4	11.2	14.8	6.3	14.6	9.5
	C	*Crotalaria anagyroides*	10.5	10.4	11.0	7.8	13.4	10.9
	D	*Flemingia macrophylla*	11.6	20.8	10.0	8.2	14.4	11.0
	E	*Chromolaena odorata*	9.8	7.2	9.6	8.3	12.5	11.0
	F	*Imperata cylindrica*	9.6	12.0	11.6	9.8	13.7	11.0
Rasyid	A	LCC	11.4	12.8	11.0	8.4	18.7	9.3
	B	*Mucuna cochensinensis*	10.9	10.8	9.0	10.0	9.3	9.8
	C	*Crotalaria anagyroides*	9.7	9.6	4.8	9.1	8.0	5.0
	D	*Flemingia macrophylla*	11.1	13.2	7.8	7.7	13.0	9.1
	E	*Chromolaena odorata*	7.3	6.8	5.2	1.0	3.6	3.6
	F	*Imperata cylindrica*	7.0	10.4	4.6	2.3	4.3	4.2
Yohanes	A	LCC	11.7	8.1	8.3	6.2	13.6	7.2
	B	*Mucuna cochensinensis*	15.7	13.2	11.2	6.8	15.7	7.7
	C	*Crotalaria anagyroides*	15.5	3.2	15.0	8.0	13.6	9.9
	D	*Flemingia macrophylla*	14.9	9.6	10.4	8.3	13.8	7.5
	E	*Chromolaena odorata*	14.0	12.0	7.6	7.3	12.1	7.8
	F	*Imperata cylindrica*	13.9	12.0	8.6	8.1	15.8	7.0
Average	**A**	**LCC**	**11.4**	**11.4**	**11.0**	**8.5**	**16.6**	**8.9**
	B	***Mucuna cochensinensis***	**12.4**	**12.8**	**11.6**	**8.8**	**14.4**	**9.8**
	C	***Crotalaria anagyroides***	**11.2**	**9.5**	**9.9**	**8.0**	**11.0**	**8.8**
	D	***Flemingia macrophylla***	**11.3**	**13.2**	**9.5**	**7.8**	**13.2**	**9.3**
	E	***Chromolaena odorata***	**9.4**	**8.4**	**7.6**	**6.5**	**9.2**	**8.2**
	F	***Imperata cylindrica***	**9.5**	**10.6**	**9.0**	**6.8**	**10.5**	**7.4**



RAS 32 a - WEST KALIMANTAN
Rubber girth at 45 months
in cover crops plots

Farmer	LCC	*Mucuna*	*Crotalaria*	*Flemingia*	*Chromolaena*	*Imperata*
Akut	41.5	44.3	41.5	38.0	33.5	37.7
Kimbon	38.8	38.8	28.0	31.9	27.8	24.5
Kolanus	40.2	38.8	38.3	39.1	34.9	38.1
Rasyid	39.9	35.3	28.3	35.6	21.4	20.5
Yohanes	35.4	43.7	44.5	41.9	39.7	41.4
Average	39.2	40.2	36.1	37.3	31.5	32.4

Anova: Two-Factor Without Replication

SUMMARY	*Count*	*Sum*	*Average*	*Variance*		
Akut	6	236.44	39.41	14.38		
Kimbon	6	189.84	31.64	36.37		
Kolanus	6	229.40	38.23	3.21		
Rasyid	6	180.99	30.17	65.19		
Yohanes	6	246.59	41.10	10.80		
LCC	5	195.81	39.16	5.45		
Mucuna	5	200.90	40.18	14.06		
Crotalaria	5	180.69	36.14	57.85		
Flemingia	5	186.38	37.28	14.10	lsd 5% =	5.42
Chromolaena	5	157.41	31.48	49.87	lsd 1% =	7.40
Imperata	5	162.07	32.41	86.57		

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*	
Farmer	573.50	4	143.38	8.48	0.00	2.87	**
Cover crop	311.59	5	62.32	3.69	0.02	2.71	*
Error	338.15	20	16.91				
Total	1223.24	29					

Mucuna	40.18	a
LCC	39.16	a
Flemingia	37.28	a
Crotalaria	36.14	a
Imperata	32.41	ab
Chromolaena	31.48	ab

a,b,c: Classification groups according to Duncan's test at 5% significance threshold

WEST KALIMANTAN - RAS 3.2a

1. Trial implementation

The trial RAS 3.2a compares various cover plants which, could reduce or suppress *Imperata cylindrica* in grasslands. Cover types were selected for their capacity to compete with *Imperata.* Performances in the field are variable according to the *Imperata* extent in the plot and the capacity of cover to develop rapidly.

2. General observations on trial

Control of imperata was variable in different plots. *Mucuna cochensinensis* has a early fast development then it regressed after producing seeds; the legume must be sown again because the plant is annual. *Flemingia macrophylla* is effective against *Imperata* but good seeds must be used to provide a uniform cover. A second sowing is often necessary to obtain good and rapid control of *Imperata.*

3. Treatment analysis

- RAS 3.2 (6 replications)

Rubber girth after 45 months

Treatments	Girth in cm (%)
Rubber with LCC	39.2 (100) a
Rubber with *Mucuna cochensinensis*	40.2 (103) a
Rubber with *Crotalaria anagyroides*	36.2 (92) a
Rubber with *Flemingia macrophylla*	37.3 (95) a
Rubber with *Chromolaena odorata*	31.5 (80) b
Rubber with *Imperata cylindrica*	32.4 (82) b

Legume cover crops (LCC) and *Mucuna* obtained the best results but *Crotalaria* and *Flemingia* are also useful covers. *Chromolaena* and *Imperata* plots are significantly inferior to other treatments. In *Chromolaena* plots, *imperata* invaded most of the plots and consequently affected rubber growth.

4. Conclusion

LCC obtained the best results in the trial. Shrub covers are effective to control *Imperata* but they need to be assisted/promoted in the early stages. Sowing or use of cuttings helps the shrub expansion. Slashing on *Chromolaena* is an effective practice to promote development of the weed.

WEST KALIMANTAN – RAS 3.2 b
Various covers including bamboo

TITLE:
Clonal rubber in agroforestry environment : rubber + selected associated trees + intercropping (first year) + covercrops. **Experimentation on covercrops and associated trees.**

OBJECTIVE/HYPOTHESE
Objectives

RAS 3 aims to associate useful trees (fruits and timber trees) with rubber, at a limited planting density, without substantial decrease in rubber yield.

- Rice is intercropped in the first year at planting time, immediately followed by covercrops in the interrows. Covercrops should not be competitive with rubber. Non viny covercrops have been chosen to limit weeding. 2 promising covercrops are being tested on large scale : Flemingia and Crotalaria. However, the 2 plots were poorly implemented. At the end of 1997 : all plots are invaded by Imperata and it has been decided to implement per field (2 rep) : 1 plot with Bamboo and 2 plots let with *Imperata*.
- Rubber is planted at normal planting density of 550 trees/ha. Associated trees, only timber trees, are planted at 92 trees/ha with a maximum number of 30 big trees/ha.

In the case of RAS 3.2/timber: all trees planted are timber trees (Dipterocarps).

RAS 3 has the same frame as RAS 2 in term of planting densities.

Hypotheses

General to RAS 3:
- It is expected that rubber growth during immature period will not be affected by associated trees competition in particular by slow-growth timber trees such as meranti, tekam, belian, keladan, nyatoh and penyaoh.

Specific to RAS 3.2 :
- Farmers do not want to grow annual intercrops. Covercrops should protect the inter-row during rubber immature period and limit Imperata. Selected covercrops are Flemingia and Crotalaria.
- non viny covercrops limits weeding and labour requirement compared to traditional viny LCC used in TCSDP technology.
- as Imperata has overcome covercrops due to poor weeding and poor implementation, covercrop is replaced by bamboo in one plot per rep.

EXPECTED OUTPUTS

To produce recommendations on components of RAS 3 concerning covercrops:

- Species of covercrops or bamboo adapted to local conditions.
- Competition between timber trees and rubber in the long term.

LOCATION: West-Kalimantan province,
Kabupaten Sanggau, Kecamatan Sanggau Kapuas,

TRIAL: 2 rep code: 1a_3295 or code "L"
Village of Kopar: 2 rep (planted in 95)

Note: Village of Engkayu: 1 rep (planted in 1995). This replication has been cancelled in July 1996 and transformed into RAS 1.1

The 2 replications are former RAS 3.1 rep where covercrops treatments have failed.

YEAR: Rubber planting: January 1995 (direct)- April 1995 (tapih)

DURATION

The first year is critical for covercrops establishment.
5 to 6 years for immature period. The first 2 years are critical in terms of growth and survivability. Then, if possible, a minimum of 3 years of production monitoring.

MATERIALS AND METHOD
Treatments

Year 1:
Local rice variety (September- February)
February/March: covercrops establishment: failure. Treatment against Imperata with Round up. Planting of covercrops in March 1996.
Planting of timber trees between March and September 1996.

Treatments: 2 types of covercrops:
A Control: LCC.
B Flemingia
C Crotalaria
Total number of plots/rep: plots.
2 replications

FIELD DESIGN in 1995/96/97

MUCUNA	FLEMINGIA	OROK2 (crotalaria)

FIELD DESIGN in 1998

MUCUNA REPLANTED	FLEMINGIA replaced by BAMBOO	OROK□ FAILURE Imperata

EXPERIMENTAL DESIGN
Randomized block design.

RUBBER

Clone: BPM 1(rep 1), RRIC 100 (rep 2). Clone is not a treatment.

FERTILIZATION
TCSDP fertilization program for NPK for the first 2 years. No fertilization later.

Rubber planting distance
Standard: 550 trees/ha: 3 x 6 meters.

Rubber weeding:

6 weeding a year, every 2 months, on a regular basis.
Year 3, 4 and 5: 3 weeding/year on the row.

INTERCROPPING

No

ASSOCIATED TREES

Planting density: 92 trees/ha: 9 x 12 meters. TIMBER TREES ONLY.
No fertilization.
Weeding: same as for rubber (6 weeding/year).

Remarks: in 1997: most of the timber trees are dead.

FIELD SIZE

PLOT SIZE: 1000 m2
NUMBER OF PLOTS PER farm: 3 plots
REPLICATION/FARM SIZE: 3 000 m2
NUMBER OF REPLICATION/farm: 3

DATA TO BE COLLECTED

- Standard data for all RAS 3 (similar to RAS 2):

RUBBER
- rubber growth measurements : diameter, height and whorls the first year every 3 months. Then girth the second year every 3 months. Sample of 30 trees per plot.

ASSOCIATED TREES
- tree growth measurements : girth every year at planting anniversary time for all trees per plot.

RICE
- date of planting
- date of harvest
- yield of 100 m2 square at 14 % water content

COVERCROPS
- Control of growth and ground cover.
- Farmer's labor for each plot.
- Soil samples per replication on 0-10 and 10-20 cm.

RAS 32 b -WEST KALIMANTAN
Effect of various cover crops on rubber girth

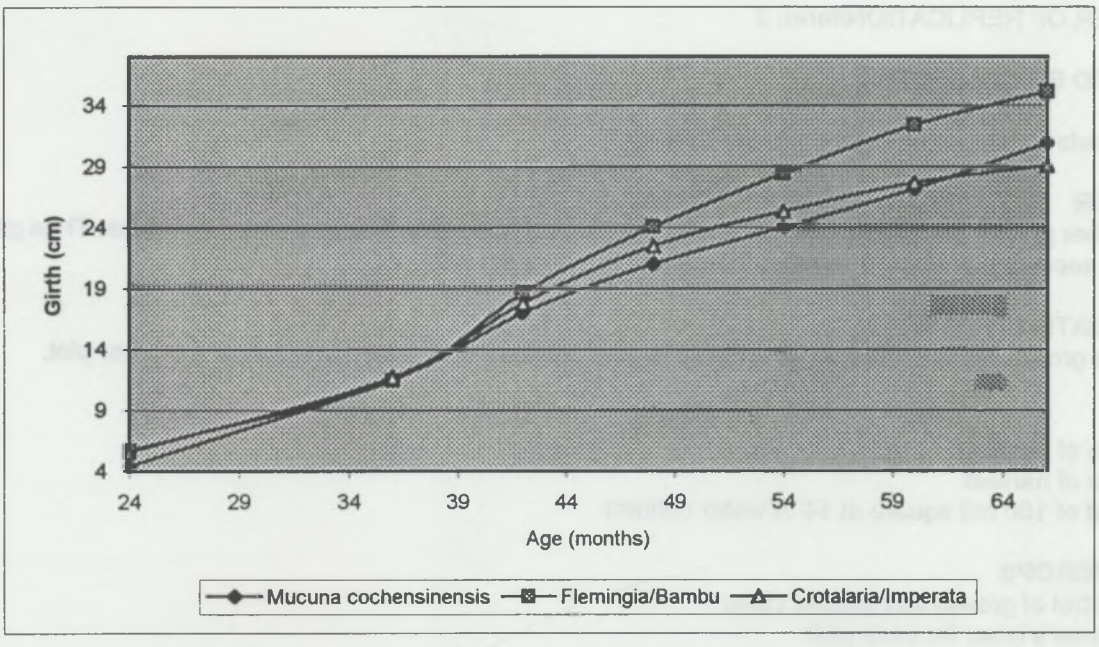
Planting February 1995 - Kopar 1

Farmer	Plot	Various cover crops	Girth (cm)						
			Feb-97	Feb-98	Aug-99	Feb-99	Aug-99	Feb-00	Aug-00
Abui	A	*Mucuna cochensinensi*	5.1	14.9	20.3	24.4	26.5	28.7	31.8
	B	*Flemingia/Bambu*	6.6	11.2	18.0	22.6	25.8	28.5	30.6
	C	*Crotalaria/Imperata*	5.6	11.7	17.8	22.5	25.3	27.7	29.1
Kai	A	*Mucuna cochensinensi*	3.7	8.1	13.7	17.7	21.5	25.5	29.9
	B	*Flemingia/Bambu*	4.8	11.7	19.3	25.5	31.1	36.2	39.6
	C	*Crotalaria/Imperata*	-	1.3	4.6	6.6	8.3	9.7	12.5 (1)

(1) Supplies

Average	**A**	***Mucuna cochensinen***	**4.4**	**11.5**	**17.0**	**21.0**	**24.0**	**27.1**	**30.9**
	B	***Flemingia/Bambu***	**5.7**	**11.4**	**18.7**	**24.1**	**28.4**	**32.4**	**35.1**
	C	***Crotalaria/Imperata***	**5.6**	**11.7**	**17.8**	**22.5**	**25.3**	**27.7**	**29.1**

Effect of cover crops on rubber growth



WEST KALIMANTAN - RAS 3.3/
Various types of Fast Growing Trees (FGT)

TITLE:
Clonal rubber in agroforestry environment: rubber + selected associated trees + intercropping (first year) + covercrops + FG (Fast growing pulp Trees). **Experimentation on associated trees: fruit, timber trees + FGT.**

OBJECTIVE/HYPOTHESE
Objectives

RAS 3 aims to associate useful trees (fruits and timber trees) with rubber, at a limited planting density, without substantial decrease in rubber yield.
Rice is intercropped in the first year at planting time, immediately followed by covercrops in the interrows. Covercrops should not be competitive with rubber. Non viny covercrops have been chosen to limit weeding (Flemingia or Crotalaria).

FGT are planted in intercrop on the associated tree row in order to provide shade (to prevent Imperata). FGT are expected to produce an additional source income for the year 7 or 8. FG is planted at 400 trees/ha at 6 x 6 m.

Rubber is planted at normal planting density of 550 trees/ha. Associated trees are fruit and timber trees and mix planted at 92 trees/ha with a maximum number of 30 big trees/ha.

RAS 3.3 has the same frame as RAS 2 + FGT

Hypotheses

General to RAS 3:
- It is expected that rubber growth during immature period will not be affected by associated trees competition.
- farmers do not want to grow annual intercrops. Covercrops should protect the inter-row during rubber immature period and limit Imperata. Selected covercrops are Flemingia and/or Crotalaria
- non viny covercrops limits weeding and labor requirement compared to traditional viny LCC used in TCSDP technology.

Specific to RAS 3.3:

- FGT provide shade in order to prevent Imperata and are not too competitive with rubber and associated trees during immature period.

EXPECTED OUTPUTS

To produce recommendations on components of RAS 3 concerning covercrops:
- combination of covercrops + FGT adapted to local conditions.
- competition between associated trees, FGT and rubber in the long term.

LOCATION: West-Kalimantan province,
Kabupaten Sanggau, Kecamatan Sanggau Kapuas,
TRIAL: code 1a_3396 or code "N"
Village of Engkayu: 3 rep (planted in 1996)

YEAR: Rubber planting: January/February 1996

DURATION

The first year is critical for covercrops establishment.
5 to 6 years for immature period. The first 2 years are critical in terms of growth and survivability. Then, if possible, a minimum of 3 years of production monitoring.
FG trees are expected to be harvested the year 7 or 8.

MATERIALS AND METHOD
Treatments

Treatment on FGT
5 plots/3 replications
A Control : Rubber alone
B Rubber + *Acacia mangium.*
C Rubber + *Paraserianthes falcataria*
D Rubber + *Gmelina arborea*
E Rubber + mixture of FGT

EXPERIMENTAL DESIGN
Randomized block system.

RUBBER
Clone: PB 260

FERTILIZATION
TCSDP fertilization program for NPK for the first 2 years. No fertilization later.

RUBBER PLANTING DISTANCE
Standard: 550 trees/ha: 3 x 6 meters.

Rubber weeding:

6 weeding a year, every 2 months, on a regular basis.
Year 3, 4 and 5: 3 weeding/year on the row.

INTERCROPPING

Year 1 :
Local rice variety (September-February)
February/March: covercrops establishment.
Planting of FGT in October 1996.
Year 2 to 5
Covercrops only.

ASSOCIATED TREES
No other associated trees.

FIELD SIZE

PLOT SIZE: 1000 m2
NUMBER OF PLOTS PER farm: 5 plots
REPLICATION/FARM SIZE: 5 000 m2
NUMBER OF REPLICATION/farm: 3

DATA TO BE COLLECTED

- Standard data for all RAS 3 (similar to RAS 2):

RUBBER

- rubber growth measurements : diameter, height and whorls the first year every 3 months. Then girth the second year every 3 months. Sample of 30 trees per plot.

ASSOCIATED TREES

- FGT tree growth measurements: girth every year at planting anniversary time for all trees per plot.

RICE

- date of planting
- date of harvest
- yield of 100 m2 square at 14 % water content

COVERCROPS

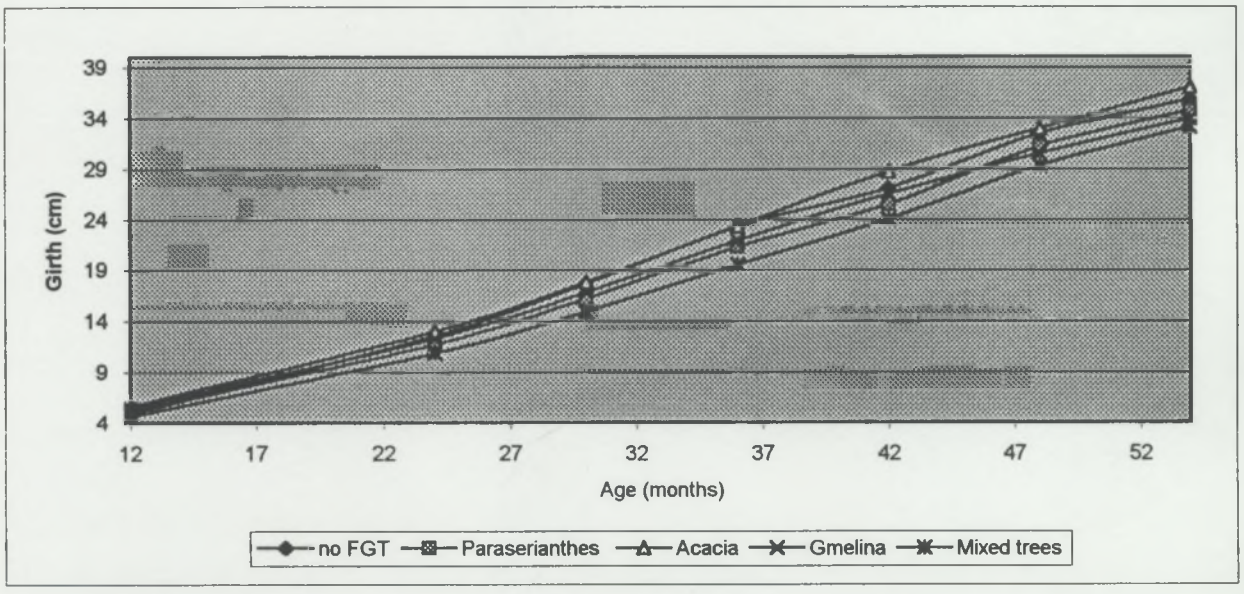
- Control of growth and ground cover.
- Farmer's labor for each plot.
- soil samples per replication on 0-10 and 10-20 cm.

RAS 33 - WEST KALIMANTAN
Effect of associated fast growing trees (FGT) on rubber girth

Planting February 1996 - Engkayu 2

Farmer	Plot	Associated FGT	Girth (cm)						
			Feb-97	Feb-98	Aug-98	Feb-99	Aug-99	Feb-00	Aug-00
Angkong	A	no FGT	4.6	9.4	14.9	20.1	23.7	28.9	31.8
	B	*Paraserianthes falcataria*	5.1	9.1	11.7	15.3	19.2	23.6	27.9
	C	*Acacia mangium*	5.8	12.9	19.5	25.7	29.6	35.2	39.0
	D	*Gmelina arborea*	6.4	14.9	21.8	28.1	31.0	35.1	37.9
	E	Mixed trees	4.9	10.8	15.3	20.3	24.1	28.7	32.6
Joni	A	no FGT	5.5	13.6	16.6	22.0	24.6	29.9	33.5
	B	*Paraserianthes falcataria*	5.4	11.3	16.2	22.0	25.4	32.2	35.5
	C	*Acacia mangium*	6.6	11.6	14.0	18.5	26.0	28.3	33.6
	D	*Gmelina arborea*	6.2	13.3	15.3	19.2	25.3	27.9	31.6
	E	Mixed trees	4.4	9.0	11.1	15.1	19.7	26.0	30.3
Noh	A	no FGT	4.5	14.6	21.4	27.8	33.0	38.7	42.1
	B	*Paraserianthes falcataria*	4.8	14.8	20.6	26.6	32.0	37.7	40.9
	C	*Acacia mangium*	4.5	14.4	19.9	25.8	30.6	35.6	38.5
	D	*Gmelina arborea*	3.5	8.7	13.3	18.4	23.3	28.5	32.3
	E	Mixed trees	4.6	12.6	18.3	23.2	28.4	33.1	36.4
Average	**A**	**no FGT**	**4.9**	**12.5**	**17.6**	**23.3**	**27.1**	**32.5**	**35.8**
	B	***Paraserianthes falcataria***	**5.1**	**11.7**	**16.2**	**21.3**	**25.5**	**31.2**	**34.8**
	C	***Acacia mangium***	**5.6**	**13.0**	**17.8**	**23.3**	**28.7**	**33.0**	**37.0**
	D	***Gmelina arborea***	**5.4**	**12.3**	**16.8**	**21.9**	**26.5**	**30.5**	**33.9**
	E	**Mixed trees**	**4.6**	**10.8**	**14.9**	**19.5**	**24.0**	**29.3**	**33.1**

Effect of FGT on rubber growth



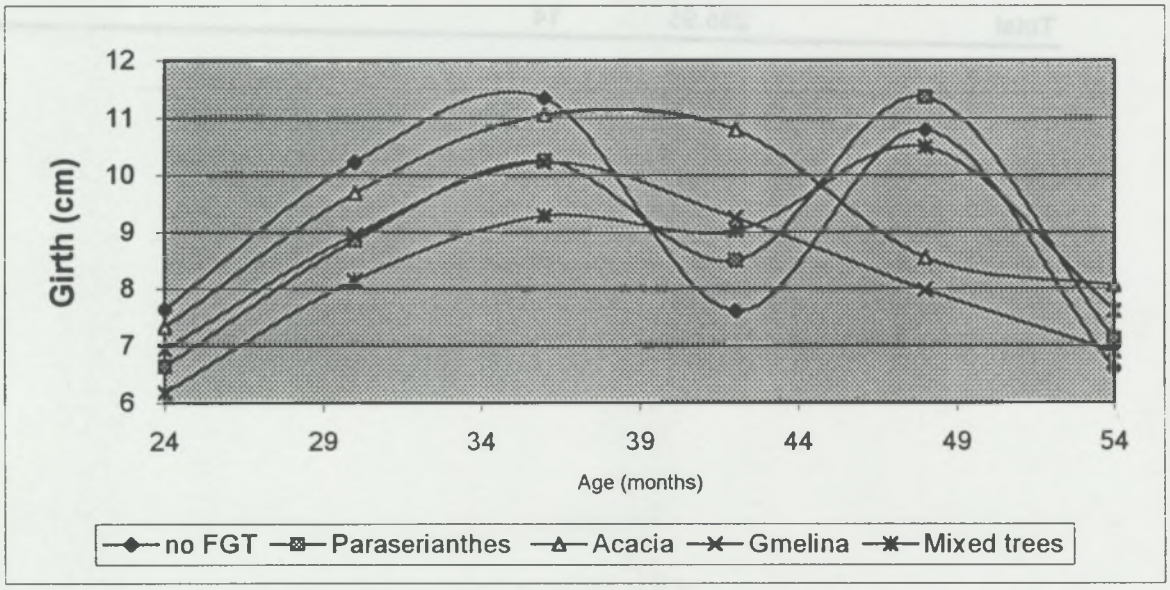
RAS 33 - WEST KALIMANTAN
Effect of associated fast growing trees (FGT) on annual rubber girth increment

Planting February 1996 - Engkayu 2

Farmer	Plot	Associated FGT	Annual girth increment (cm)					
			Feb-97	Feb-98	Aug-98	Feb-99	Aug-99	Feb-00	Aug-00
Angkong	A	no FGT		4.8	11.0	10.4	7.2	10.3	5.8
	B	*Paraserianthes falcataria*		4.0	5.2	7.1	7.8	9.0	8.5
	C	*Acacia mangium*		7.1	13.2	12.4	7.8	11.1	7.7
	D	*Gmelina arborea*		8.5	13.7	12.6	5.8	8.3	5.6
	E	Mixed trees		5.9	9.0	10.0	7.5	9.2	7.9
Joni	A	no FGT		8.1	6.1	10.9	5.2	10.6	7.3
	B	*Paraserianthes falcataria*		5.9	9.8	11.6	6.8	13.7	6.5
	C	*Acacia mangium*		5.0	4.9	9.0	15.0	4.5	10.7
	D	*Gmelina arborea*		7.1	3.9	7.9	12.1	5.3	7.4
	E	Mixed trees		4.6	4.1	8.0	9.3	12.7	8.5
Noh	A	no FGT		10.1	13.6	12.8	10.4	11.5	6.7
	B	*Paraserianthes falcataria*		10.0	11.6	12.0	10.9	11.4	6.3
	C	*Acacia mangium*		9.9	11.0	11.8	9.6	10.0	5.8
	D	*Gmelina arborea*		5.2	9.2	10.1	9.8	10.4	7.7
	E	Mixed trees		8.0	11.3	9.8	10.3	9.5	6.5

Average	**A**	**no FGT**	**7.6**	**10.2**	**11.3**	**7.6**	**10.8**	**6.6**
	B	***Paraserianthes falcataria***	**6.6**	**8.8**	**10.2**	**8.5**	**11.4**	**7.1**
	C	***Acacia mangium***	**7.3**	**9.7**	**11.1**	**10.8**	**8.5**	**8.1**
	D	***Gmelina arborea***	**6.9**	**8.9**	**10.2**	**9.2**	**8.0**	**6.9**
	E	**Mixed trees**	**6.2**	**8.2**	**9.3**	**9.0**	**10.5**	**7.6**

Effect of FGT on annual girth increment



RAS 33 - WEST KALIMANTAN
Rubber girth at 54 months
in fast growing trees plots

	Different FGT with rubber				
Farmer	no FGT	*Paraser.*	*Acacia*	*Gmelina*	Mixed trees
Angkong	31.8	27.9	39.0	37.9	32.6
Joni	33.5	35.5	33.6	31.6	30.3
Noh	42.1	40.9	38.5	32.3	36.4
Average	35.8	34.8	37.0	33.9	33.1

Anova: Two-Factor Without Replication

SUMMARY	*Count*	*Sum*	*Average*	*Variance*
Angkong	5	169.17	33.83	21.07
Joni	5	164.53	32.91	4.07
Noh	5	190.20	38.04	15.13
no FGT	3	107.40	35.80	30.54
Paraser.	3	104.29	34.76	42.72
Acacia	3	111.12	37.04	8.78
Gmelina	3	101.81	33.94	11.96
Mixed trees	3	99.28	33.09	9.57

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Farmer	74.85	2	37.42	2.26	0.17	4.46
Type of FGT	28.79	4	7.20	0.44	0.78	3.84
Error	132.31	8	16.54			
Total	235.95	14				

WEST KALIMANTAN - RAS 3.3

1. Trial implementation

The trial RAS 3.3 compares various fast growing trees (FGT) which, can reduce or suppress *Imperata cylindrica* in grasslands. Trees species were selected for their capacity to compete with *Imperata* and to provide additional income if a market for pulp wood exist.

2. General observations on trial

Control of imperata by shading become effective after a delay of two years. *Acacia mangium* was found to be the most effective FGT to control imperata because of its dense canopy. Its vertical development is equal to rubber at the end of the third year. Afterwards *Acacia mangium* grows higher that rubber and it start to compete. *Gmelina arborea* did not grow well in trial conditions. In July 1999, most of trees were pruned at 2 meter high because FGT competed for light with rubber.

3. Treatment analysis

- RAS 3.3 (3 replications) Rubber girth at 54 months

Treatments	Girth in cm (%)
Rubber alone	35.8 (100)
Rubber with *Paraserianthes falcataria*	34.8 (97)
Rubber with *Acacia mangium*	37.0 (103)
Rubber with *Gmelina arborea*	33.9 (95)
Rubber with Mixed FGT trees	33.1 (92)

Fast growing trees didn't affect rubber growth during the first 3 years and *Acacia mangium* effectively control *Imperata,* thanks to its vigorous development. After 4 years, Fast growing trees were tipped at 2 m high because of severe competition with surrounding rubber trees.

4. Conclusion

Fast growing trees are effective to control *Imperata* during the first 3 years. After 36 months there is a clear indication of competition between FGT and rubber; keeping robust trees like *Acacia mangium* could be detrimental to rubber. Association of fast growing trees and rubber needs a new assessment regarding spacing. Wider inter-rows are needed to prevent competition with rubber but consequently, rubber density must decrease. A change in rubber spacing is justified only if a market for pulpwood exists and that activity proven profitable to smallholders.

WEST KALIMANTAN - RAS 3.4/
Various types of Fast Growing Trees (FGT)

TITLE:
Clonal rubber in agroforestry environment: rubber + FGT[1] + intercropping (first year) + covercrops.
Experimentation on combination rubber + FGT.

OBJECTIVE/HYPOTHESE
Objectives

RAS 3 aims to associate useful trees (fruits and timber trees) with rubber, at a limited planting density, without substantial decrease in rubber yield.
Rice is intercropped in the first year at planting time, immediately followed by covercrops in the interrows. Covercrops should not be competitive with rubber. Non viny covercrops have been chosen to limit weeding (Flemingia or Crotalaria). Covercrops is not a treatment.

FGT are planted in intercrop in the inter-row (without any other associated trees) in order to provide shade (to prevent Imperata). FGT are expected to produce an additionnal source income for the year 7 or 8. FGT are planted at 550 trees/ha at 6 x 3 m.

Rubber is planted at normal planting density of 550 trees/ha.

Hypotheses

General to RAS 3:
- It is expected that rubber growth during immature period will not be affected by associated FGT competition.
- farmers do not want to grow annual intercrops. Covercrops should protect the inter-row during rubber immature period and limit Imperata. Selected covercrops are Flemingia and/or Crotalaria
- non viny covercrops limits weeding and labor requirement compared to traditional viny LCC used in TCSDP technology.

Specific to RAS 3.3:

- FGT provide shade in order to prevent Imperata and are not too competitive with rubber.

EXPECTED OUTPUTS

To produce recommendations on components of RAS 3 concerning covercrops:
- combination of covercrops + FGT adapted to local conditions.
- competition between FGT and rubber in the long term.

LOCATION : West-Kalimantan province,
Kabupaten Sanggau, Kecamatan Sanggau Kapuas,

TRIAL code 1a_3496 or code "0"
Village of Trimulia: 3 rep (planted in 1996)

YEAR of planting:
Planting of rubber: February 1996

[1] FGT = (Fast Growing Pulp Trees).

DURATION

The first year is critical for covercrops establishment.
5 to 6 years for immature period. The first 2 years are critical in terms of growth and survivability. Then, if possible, a minimum of 3 years of production monitoring.
FG trees are expected to be harvested the year 7 or 8.

MATERIALS AND METHOD
Treatments

Treatment 1
5 plots/4 rep
A Control: rubber alone
B Rubber + associated fruit and timber trees + *Acacia mangium*.
C Rubber + associated fruit and timber trees + *Paraserianthes falcataria*
D Rubber + associated fruit and timber trees + *Gmelina arborea*
E Rubber + associated fruit and timber trees + mix of FGT

Treatments 2: 2 types of covercrops:
A Flemingia (2 rep)
B Crotalaria (2 rep)
Total number of plots/rep: 4 plots.

EXPERIMENTAL DESIGN
Split plot with main treatment on FGT

RUBBER

Clone: PB 260

FERTILIZATION
TCSDP fertilization program for NPK for the first 2 years. No fertilization later.

RUBBER PLANTING DISTANCE
Standard: 550 trees/ha: 3 x 6 meters.

RUBBER WEEDING :

6 weeding a year, every 2 months, on a regular basis.
Year 3, 4 and 5: 3 weeding/year on the row.

INTERCROPPING

Year 1 :
Local rice variety (September-February)
February/March : covercrops establishment.
Planting of associated trees and FGT in October 1996.
Year 2 to 5
Covercrops only.

ASSOCIATED TREES

Planting density: 92 trees/ha : 9 x 12 meters.
No fertillization.
Weeding: same as for rubber (6 weeding/year).

FIELD SIZE

PLOT SIZE: 1000 m2
NUMBER OF PLOTS PER farm: 5 plots
REPLICATION/FARM SIZE: 5 000 m2
NUMBER OF REPLICATION/farm: 4

DATA TO BE COLLECTED

- Standard data for all RAS 3 (similar to RAS 2):

RUBBER

- rubber growth measurements : diameter, height and whorls the first year every 3 months. Then girth the second year every 3 months. Sample of 30 trees per plot.

ASSOCIATED TREES

- tree growth measurements : girth every year at planting anniversary time for all trees per plot.

RICE

- date of planting
- date of harvest
- yield of 100 m□ square at 14 % water content

COVERCROPS

- Control of growth and ground cover.
- Farmer's labor for each plot.
- Soil samples per replication on 0-10 and 10-20 cm.

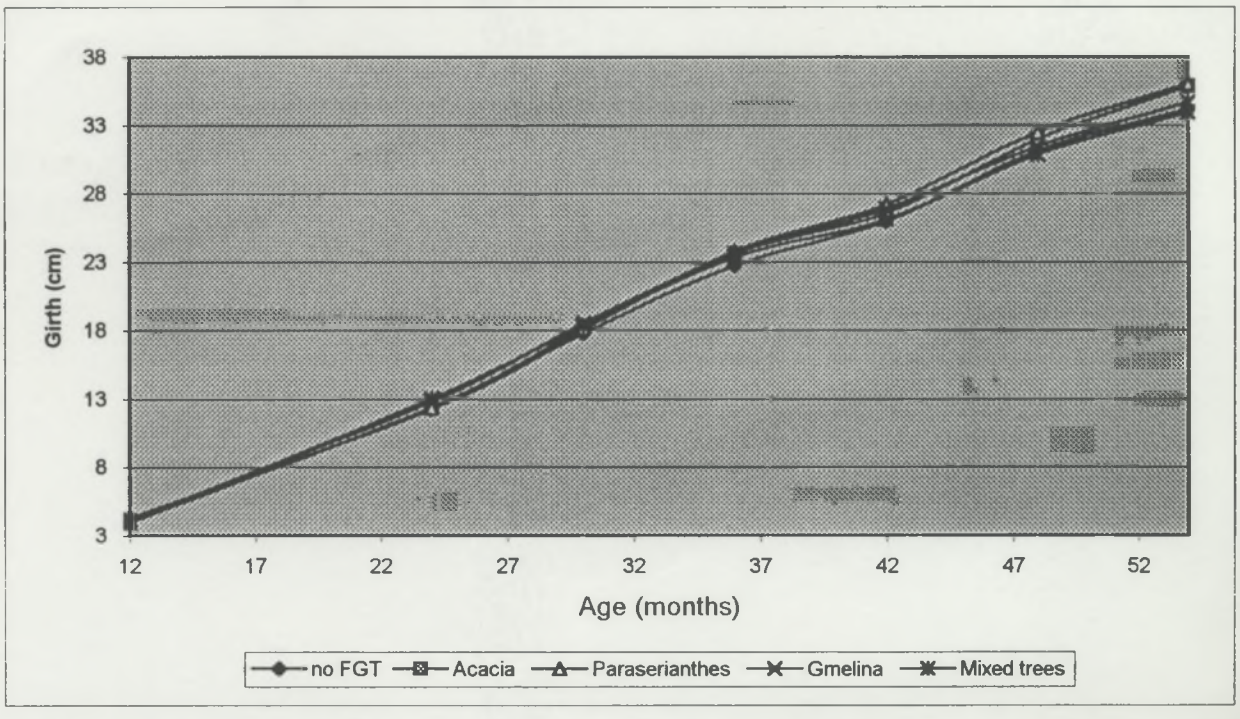
RAS 34 - WEST KALIMANTAN
Effect of associated fast growing trees (FGT) on rubber girth

Planting February 1996 - Trimulia

Farmer	Plot	Associated FGT	Girth (cm)						
			Feb-97	Feb-98	Aug-98	Feb-99	Aug-99	Feb-00	Aug-00
Margono	A	no FGT	3.2	9.8	15.0	19.5	22.0	27.3	28.4
	B	*Acacia mangium*	3.2	12.1	17.7	23.9	26.8	31.7	34.9
	C	*Paraserianthes falcataria*	3.2	9.0	14.1	19.9	23.4	29.0	31.9
	D	*Gmelina arborea*	3.4	10.4	15.6	20.2	23.1	26.4	28.2
	E	Mixed trees	3.2	11.6	16.4	20.6	22.7	26.6	28.4
Sarjono	A	no FGT	5.2	15.6	22.0	26.8	30.9	35.0	38.5
	B	*Acacia mangium*	3.9	13.4	19.6	24.7	28.1	33.9	37.9
	C	*Paraserianthes falcataria*	4.6	15.1	21.1	26.4	30.0	34.6	38.4
	D	*Gmelina arborea*	4.9	15.5	21.9	27.4	31.3	36.0	39.7
	E	Mixed trees	5.2	15.9	21.9	26.9	30.3	35.3	38.6
Sriadi	A	no FGT	4.4	11.4	16.3	21.8	25.0	31.0	35.6
	B	*Acacia mangium*	4.9	11.6	17.1	22.3	24.8	30.3	34.7
	C	*Paraserianthes falcataria*	4.3	13.0	19.2	25.0	28.2	33.8	37.7
	D	*Gmelina arborea*	4.2	12.6	18.1	23.1	26.3	31.9	36.2
	E	Mixed trees	3.4	11.6	16.8	22.4	25.3	30.7	34.9

Average	**A**	**no FGT**	**4.3**	**12.3**	**17.8**	**22.7**	**25.9**	**31.1**	**34.2**
	B	***Acacia mangium***	**4.0**	**12.4**	**18.1**	**23.6**	**26.6**	**31.9**	**35.8**
	C	***Paraserianthes falcataria***	**4.0**	**12.3**	**18.1**	**23.8**	**27.2**	**32.5**	**36.0**
	D	***Gmelina arborea***	**4.2**	**12.8**	**18.5**	**23.6**	**26.9**	**31.4**	**34.7**
	E	**Mixed trees**	**3.9**	**13.0**	**18.4**	**23.3**	**26.1**	**30.8**	**33.9**

Effect of FGT on rubber growth



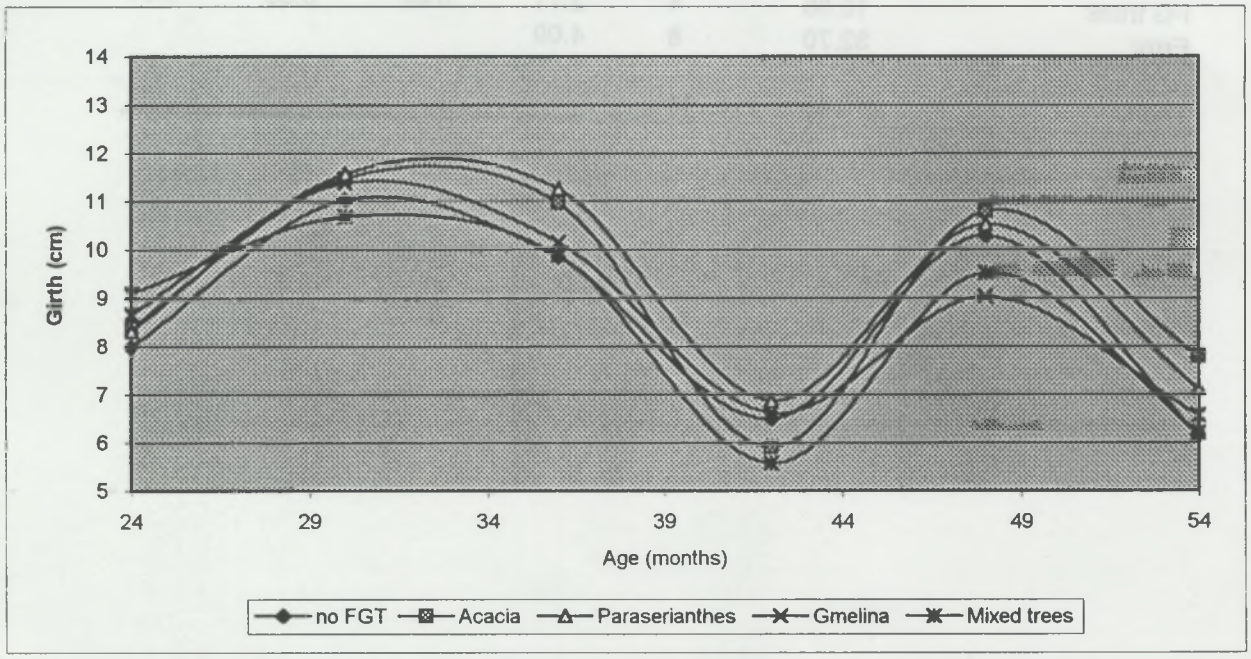
RAS 34 - WEST KALIMANTAN
Effect of associated fast growing trees (FGT) on annual rubber girth increment

Planting February 1996 - Engkayu

Farmer	Plot	Associated FGT	Annual girth increment (cm)						
			Feb-97	Feb-98	Aug-98	Feb-99	Aug-99	Feb-00	Aug-00
Margono	A	no FGT		6.6	10.4	9.1	4.9	10.7	2.1
	B	*Acacia mangium*		8.9	11.0	12.4	5.8	9.8	6.6
	C	*Paraserianthes falcataria*		5.8	10.3	11.5	7.1	11.2	5.9
	D	*Gmelina arborea*		7.0	10.4	9.2	5.7	6.6	3.7
	E	Mixed trees		8.4	9.7	8.4	4.2	7.8	3.5
Sarjono	A	no FGT		10.4	12.8	9.6	8.1	8.2	7.0
	B	*Acacia mangium*		9.5	12.4	10.2	6.8	11.6	8.0
	C	*Paraserianthes falcataria*		10.5	12.0	10.7	7.1	9.2	7.7
	D	*Gmelina arborea*		10.6	12.8	11.1	7.7	9.3	7.5
	E	Mixed trees		10.7	12.0	10.0	6.7	10.0	6.7
Sriadi	A	no FGT		7.0	9.9	10.8	6.5	11.9	9.3
	B	*Acacia mangium*		6.7	11.0	10.3	5.2	11.0	8.7
	C	*Paraserianthes falcataria*		8.7	12.4	11.6	6.4	11.3	7.8
	D	*Gmelina arborea*		8.4	11.0	10.2	6.4	11.1	8.5
	E	Mixed trees		8.2	10.4	11.3	5.7	10.7	8.4

Average	**A**	**no FGT**	**8.0**	**11.0**	**9.8**	**6.5**	**10.3**	**6.2**
	B	***Paraserianthes falcataria***	**8.4**	**11.5**	**11.0**	**5.9**	**10.8**	**7.8**
	C	***Acacia mangium***	**8.3**	**11.6**	**11.3**	**6.9**	**10.5**	**7.1**
	D	***Gmelina arborea***	**8.7**	**11.4**	**10.2**	**6.6**	**9.0**	**6.6**
	E	**Mixed trees**	**9.1**	**10.7**	**9.9**	**5.6**	**9.5**	**6.2**

Effect of FGT on annual girth increment



RAS 34 - WEST KALIMANTAN
Rubber girth at 54 months
in fast growing trees plots

Farmer	no FGT	*Paraser.*	*Acacia*	*Gmelina*	Mixed trees
Margono	28.4	34.9	31.9	28.2	28.4
Sarjono	38.5	37.9	38.4	39.7	38.6
Sriadi	35.6	34.7	37.7	36.2	34.9
Average	34.2	35.8	36.0	34.7	33.9

Anova: Two-Factor Without Replication

SUMMARY	*Count*	*Sum*	*Average*	*Variance*
Margono	5	151.81	30.36	8.97
Sarjono	5	193.05	38.61	0.44
Sriadi	5	179.05	35.81	1.48
no FGT	3	102.48	34.16	27.00
Paraser.	3	107.51	35.84	3.12
Acacia	3	108.03	36.01	12.73
Gmelina	3	104.07	34.69	34.48
Mixed trees	3	101.82	33.94	26.99

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*	
Farmer	175.92	2	87.96	21.52	0.00	4.46	**
FG trees	10.86	4	2.71	0.66	0.63	3.84	
Error	32.70	8	4.09				
Total	219.48	14					

WEST KALIMANTAN - RAS 3.4

1. Trial implementation

The trial RAS 3.4 compares various fast growing trees (FGT) which, can reduce or suppress *Imperata cylindrica* in grasslands. Trees species were selected for their capacity to compete with *Imperata* and to provide additional income if a market for pulpwood exists. *Flemingia* and *Crotalaria* were also used as cover crop to help a rapid control of *Imperata*.

2. General observations on trial

Control of imperata by shading become effective after a delay of two years. *Acacia mangium* was found to be the most effective FGT to control imperata because of its dense canopy. Its vertical development is equal to rubber at the end of the third year. *Acacia mangium* was pruned at 2 m. high in year 4 to prevent competition with rubber. *Gmelina arborea* did not grow as fast than Acacia mangium but it tolerates frequent prunings by emiting many new branches. *Flemingia* was helpful to control *Imperata* but dissemination of *Flemingia* but seeds or cutting is time consuming.

3. Treatment analysis

- RAS 3.4 (3 replications). Rubber girth at 54 months

Treatments	Girth in cm (%)
Rubber alone	34.2 (100)
Rubber with *Paraserianthes falcataria*	35.8 (105)
Rubber with *Acacia mangium*	36.0 (105)
Rubber with *Gmelina arborea*	34.7 (101)
Rubber with Mixed FGT trees	33.9 (99)

Fast growing trees didn't affect rubber growth during the first 3 years and *Acacia mangium* effectively control *Imperata,* thanks to its vigorous development. *Acacia mangium* provide a favorable environment in the first 3 year: conservation of soil moisture and building up organic litter on the ground. As in other trials, fast growing trees were tipped at 2 m high, because of severe competition with surrounding rubber trees.

4. Conclusion

Fast growing trees are effective to control *Imperata* during the first 3 years. As *Acacia mangium* grows faster and higher than rubber trees must be tipped during the 4th year. Association of fast growing trees and rubber needs a new assessment regarding spacing between the two species.