SMALLHOLDER RUBBER AGROFORESTRY PROJECT
(SRAP)

ANNUAL TECHNICAL REPORT 2001

RUBBER AGROFORESTRY SYSTEM (RAS)

ON-FARM EXPERIMENTATION IN INDONESIA

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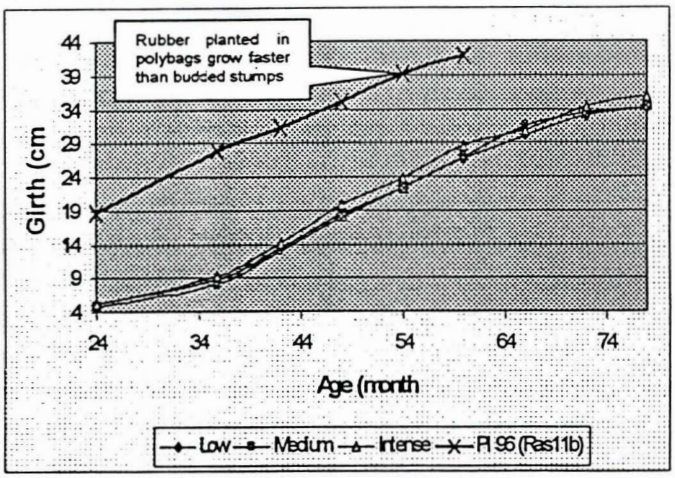
shrubs and trees control weeds by shading. The system have similarities with «*jungle rubber*» widely practiced by smallholders therefore, RAS 1 is expected to be easily adopted by farmers. The promotion and conservation of local biodiversity in the system is an additional advantage giving rubber an environment-friendly crop label.

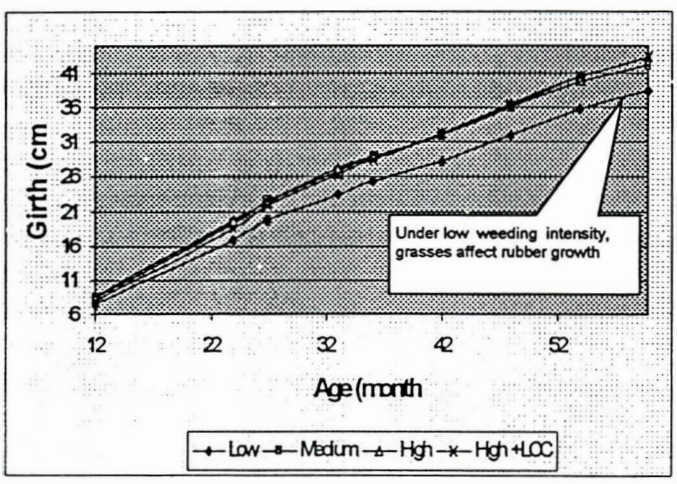
1. Effect of weeding intensity on rubber growth

RAS1.1a trial- West Kalimantan



In the RAS1.1a trial, intensive weeding did not improve rubber growth performances over a limited weeding. Rubber was planted as budded stumps and the plant growth observed was far lower than rubber planted in polybag as in RAS 11b trial. High intensity of weeding on rubber planting row did not improve significantly rubber performances. The frequency of weeding must be decided according to the prevalent vegetation. Four weedings a year are enough to promote satisfactory rubber growth.

RAS 11b trial – West Kalimantan



In farms where the density of *Imperata* or grasses is high, 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 affects rubber growth if grasses or *Imperata* are present.

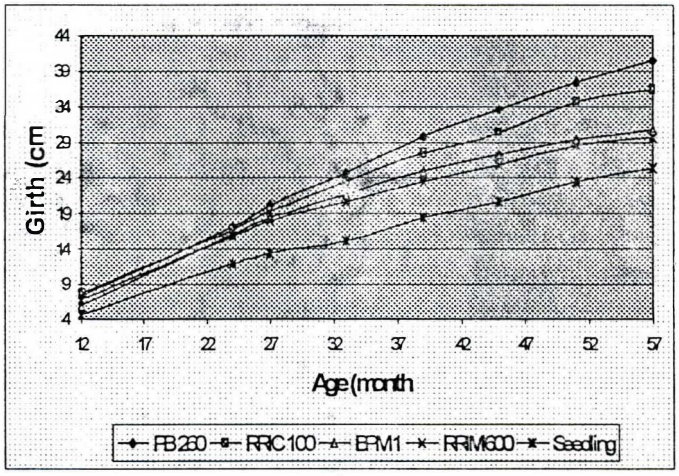
Conditions for successful RAS 1 implementation

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

2. *Testing various rubber clone in RAS 1 environment*

RAS 1.2a and b- West Kalimantan

The trials confirmed the excellent growth performances of PB 260 and RRIC 100 rubber clones. Other clones namely BPM 1 and RRIM 600 grow significantly slower than PB260. BPM 1 clone suffered a physiological leaf fall (wintering) which affected growth in 1999. Seedings which are considerd as more adapted to the harsh environment of jungle rubber are inferior to rubber clones in the trials.



Performances of PB 260 and RRIC 100 confirmed that rubber clones are suitable as planting material for use in jungle rubber environment. Rubber clone adoption in jungle rubber could be a significant booster to improve rubber productivity.

Rubber planting material recommended in RAS

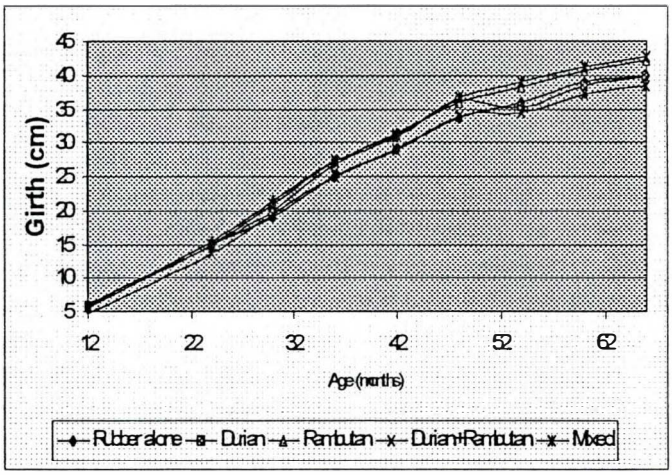
PB 260 and RRIC 100 have obtained the best performance in jungle rubber environment. These clones have confirmed their tolerance to current leaf diseases therefore they can be recommended for a wider use by smallholders.

RAS 2 Trials

These trials associate annual and perennial crops to generate additional income to rubber. They are also useful in reducing weeding requirement for rubber. Annual crops like upland rice and legumes (peanut or mung bean) provide some income during immature period and fruit trees can provide additional income afterwards.

Association with fruit trees

RAS 2.1a and b West Kalimantan



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.

Conditions for successful RAS 2 implementation

- **Well-developed plants raised in polybag to obtain a fast initial growth.**
- **Weeding properly performed at regular times (4 times a year) on rubber and fruit trees.**
- **Fruit trees found suitable in trials are rambutan and jackfruit trees. Unselected durians grow very slowly; grafted durians could give early harvest but plants are expensive and seldom available.**

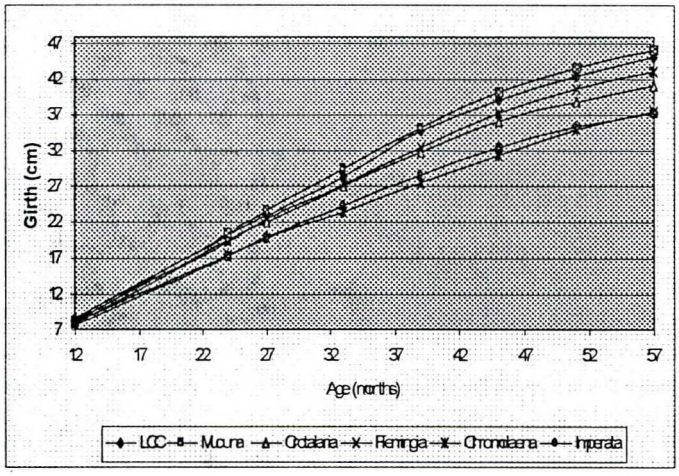
RAS 3 trials

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 & b- West Kalimantan

Pueraria javanica is an effective cover *Imperata*. Legume shrubs like *Crotalaria mucronata* and *Flemingia macrophylla* are not as effective as pueraria to control imperata. Seed availability in the market is also a problem.

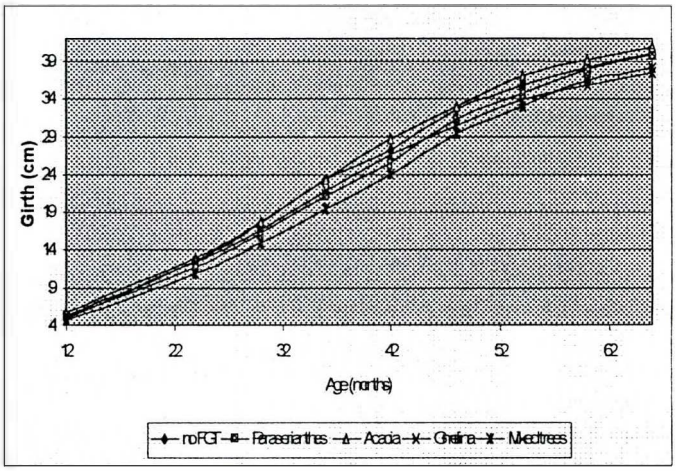


Mucuna is not effective in controlling *Imperata* due to its short life span and it needs to be re-planted every year. *Mucuna* should be associated with *Pueraria* because it helps the establishment of the later. In pure *Imperata* and *Chromolaena odorata* plots, rubber growth is significantly affected 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. *Rubber with 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.

Conditions for successful RAS 3 implementation

- **Well-developed plants raised in polybag to obtain a fast initial growth.**
- **Weeding properly performed at regular times (4 times a year) on rubber trees.**
- **Acacia mangium is effective to control *imperata* but as it must be cut after 4 year so it can not be sold as pulpwood but only be used as firewood.**

General conclusions 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 trial 1.2 a &b . Initial growth during the 6 first months is critical to ensure good performances.

It is expected that rubber trees can be tapped at the age of 5.5 years in Sumatra and 6-6.5 years in West Kalimantan. Agroforestry systems tested in RAS trials have confirmed that growth performances are similar to those obtained under monoculture conditions.

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 noxious weeds. Weeding is still needed on the rubber row but after two years weeding intensity can be reduced drastically.

5. Agroforestry practices.

Rubber agroforestry trials have confirmed that Rubber Agroforestry Systems are suitable alternatives to rubber monoculture. Rubber farmers have suffered of low rubber prices during the year 2001. Rubber agroforestry systems open new opportunities in rubber development by: increasing rubber productivity, reducing maintenance costs, generating additional incomes other than rubber, and helping the conservation of local biodiversity.

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RAS TRIALS IN WEST KALIMANTAN

RAS 1.1

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

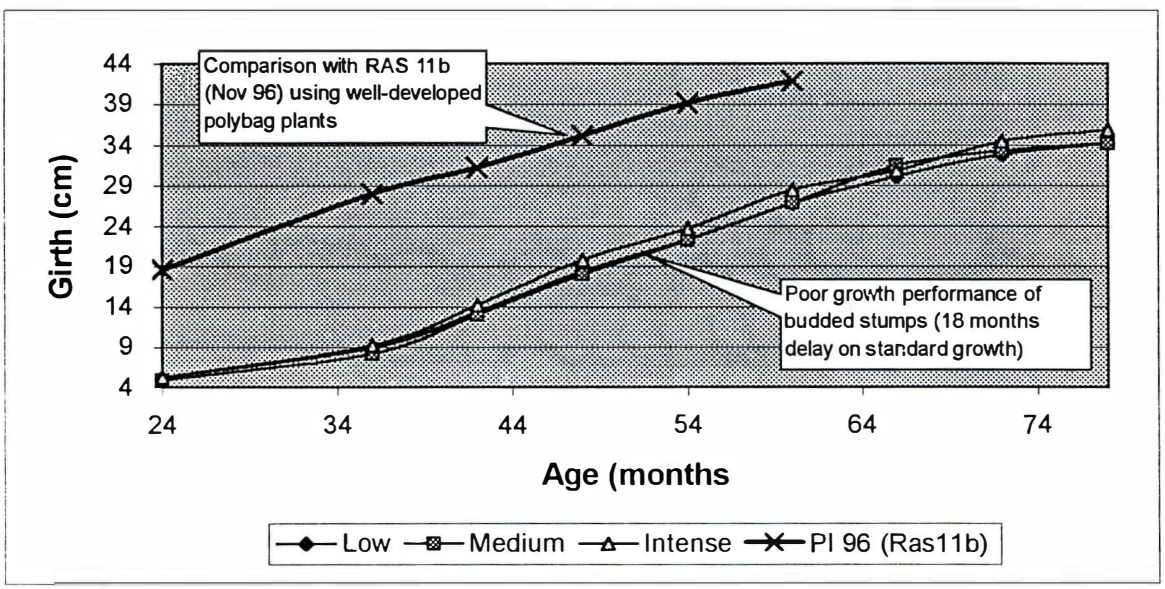
Effect of weeding intensity on rubber girth

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	Feb-01	Aug-01
Fransisco	Low	3.6	4.4	8.9	13.4	17.6	21.7	25.8	29.4	32.4
	Medium	3.7	4.8	9.0	14.5	19.7	25.0	28.8	32.7	35.9
	Intense	3.8	5.2	9.9	15.4	20.1	25.6	29.7	33.4	35.9
Stepanus	Low	6.6	10.4	13.5	20.8	24.8	28.6	31.9	33.4	
	Medium	6.5	13.8	18.8	25.0	29.1	32.5	35.9	38.0	
	Intense	6.4	13.0	18.5	24.0	27.7	31.7	34.6	36.7	
Jampi 2	Low	4.4	8.6	13.2	17.8	21.7	27.6	32.6	35.4	35.7
	Medium	4.2	5.7	10.0	14.3	17.0	21.5	25.4	27.2	29.7
	Intense	3.9	6.1	10.6	14.6	19.2	24.3	28.1	30.4	32.0
Sudin 1	Low	5.1	10.9	16.5	20.8	24.1	28.0	31.3	35.1	36.6
	Medium	5.9	10.0	15.3	19.9	23.7	28.2	32.1	35.3	36.6
	Intense	6.1	9.4	13.5	18.0	20.9	25.0	28.4	30.9	34.2
Apan	Low	4.9	10.2	15.6	20.8	24.8	30.4	32.6	35.7	36.4
	Medium	3.6	6.6	10.8	15.4	19.9	24.1	28.2	31.9	32.1
	Intense	6.0	12.1	17.2	24.8	27.5	31.8	33.6	36.4	36.8
Otol	Low	6.4	8.7	12.1	16.6	21.2	24.3	26.2	27.9	29.8
	Medium	5.1	8.3	14.0	19.0	24.4	29.9	32.7	34.7	36.5
	Intense	5.2	9.7	15.5	21.9	26.7	32.3	35.6	38.6	40.5

Average	**Low**	**5.2**	**8.9**	**13.3**	**18.4**	**22.4**	**26.8**	**30.1**	**32.8**	**34.2**
	Medium	**4.8**	**8.2**	**13.0**	**18.0**	**22.3**	**26.9**	**30.5**	**33.3**	**34.2**
	Intense	**5.2**	**9.3**	**14.2**	**19.8**	**23.7**	**28.5**	**31.7**	**34.4**	**35.9**

Effect of weeding on rubber growth



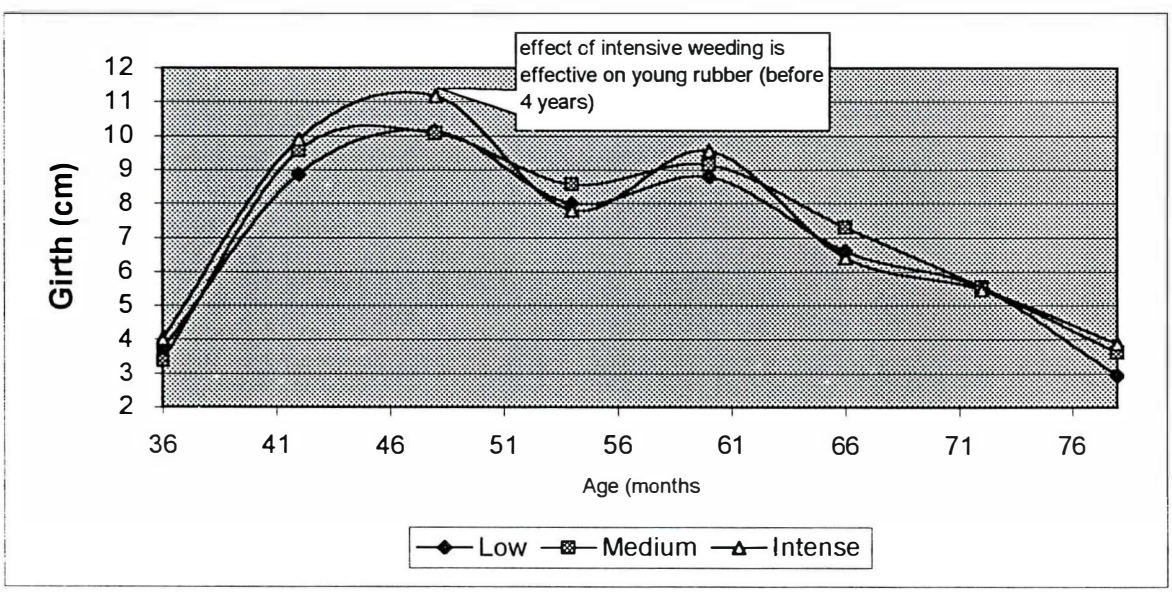
RAS 11a - WEST KALIMANTAN

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	Feb-01	Aug-01
Fransisco	Low		0.8	9.0	9.0	8.4	8.3	8.1	7.1	6.0
	Medium		1.1	8.4	11.0	10.4	10.6	7.6	7.7	6.5
	Intense		1.4	9.4	11.0	9.4	11.0	8.1	7.5	5.0
Stepanus	Low		3.8	6.2	14.6	8.0	7.7	6.5	3.1	
	Medium		7.3	10.0	12.4	8.2	6.8	6.7	4.2	
	Intense		6.6	11.0	11.0	7.4	8.0	5.8	4.1	
Jampi 2	Low		4.2	9.2	9.2	7.8	11.8	9.9	5.6	0.7
	Medium		1.5	8.6	8.6	5.4	9.0	7.8	3.5	5.0
	Intense		2.2	9.0	8.0	9.2	10.3	7.6	4.6	3.2
Sudin 1	Low		5.8	11.2	8.6	6.6	7.8	6.5	7.7	3.0
	Medium		4.1	10.6	9.2	7.6	9.0	7.8	6.4	2.6
	Intense		3.3	8.2	9.0	5.8	8.2	6.7	5.1	6.5
Apan	Low		5.3	10.8	10.4	8.0	11.1	4.6	6.1	1.3
	Medium		3.0	8.4	9.2	9.0	8.5	8.1	7.4	0.4
	Intense		6.1	10.2	15.2	5.4	8.7	3.5	5.7	0.8
Otol	Low		2.3	6.8	9.0	9.2	6.1	4.0	3.4	3.7
	Medium		3.2	11.4	10.0	10.8	11.0	5.6	4.0	3.6
	Intense		4.5	11.6	12.8	9.6	11.2	6.7	5.9	3.9
Average	**Low**		**3.7**	**8.9**	**10.1**	**8.0**	**8.8**	**6.6**	**5.5**	**2.9**
	Medium		**3.4**	**9.6**	**10.1**	**8.6**	**9.2**	**7.3**	**5.5**	**3.6**
	Intense		**4.0**	**9.9**	**11.2**	**7.8**	**9.6**	**6.4**	**5.5**	**3.9**

Effect of weeding on annual girth increment



RAS 11a - WEST KALIMANTAN
Rubber girth at 72 months

Farmer	Low	Medium	Intense	Average
Fransisco	29.4	32.7	33.4	31.83
Stepanus	33.4	38.0	36.7	36.01
Jampi 2	35.4	27.2	30.4	30.99
Sudin 1	35.1	35.3	30.9	33.79
Apan	35.7	31.9	36.4	34.67
Otol	27.9	34.7	38.6	33.73
average	32.81	33.29	34.41	33.50

Anova: Two-Factor Without Replication

SUMMARY	*Count*	*Sum*	*Average*	*Variance*		
Fransisco	3	95.48	31.83	4.72		
Stepanus	3	108.02	36.01	5.49		
Jampi 2	3	92.96	30.99	17.13		
Sudin 1	3	101.36	33.79	6.15		
Apan	3	104.02	34.67	5.95		
Otol	3	101.20	33.73	29.03		
Low	6	196.87	32.81	11.29	ssd 5% =	4.62
Medium	6	199.73	33.29	13.58	ssd 1% =	6.57
Intense	6	206.44	34.41	11.07		

ANOVA

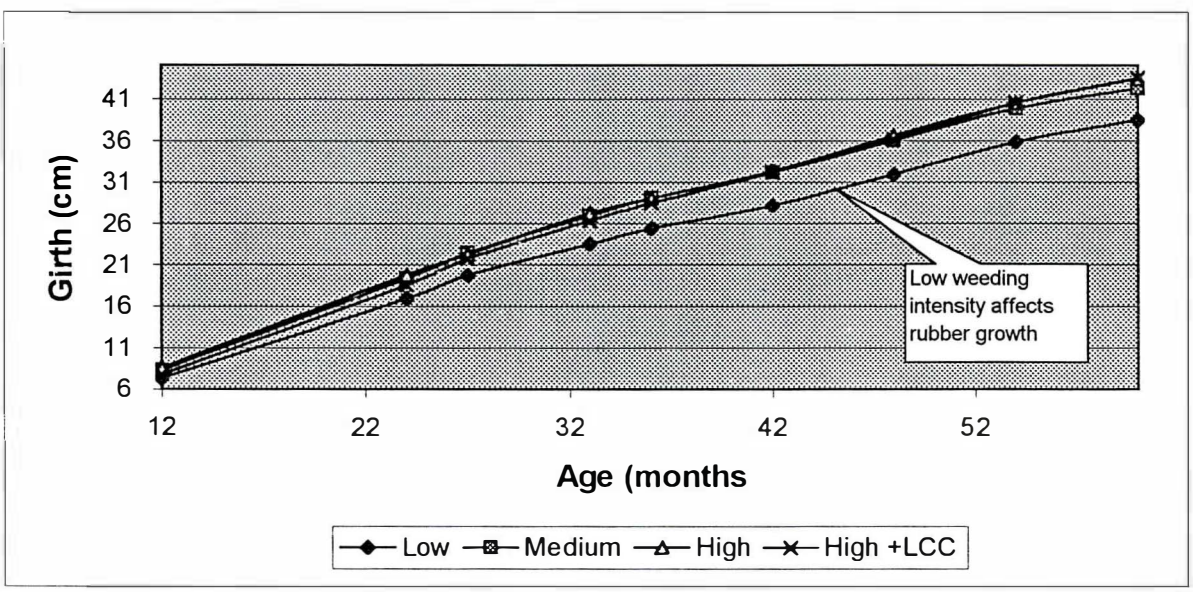
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Farmer	50.76	5	10.15	0.788	0.582	3.326
Weeding	8.03	2	4.02	0.312	0.739	4.103
Error	128.91	10	12.89			
Total	187.70	17				

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	Nov-00	Feb-01	Nov-01
Latin	Low	8.1	16.8	19.9	24.8	27.5	31.3	36.2	41.2	44.6
	Medium	8.8	18.5	21.8	27.3	30.6	34.8	40.5	45.8	48.7
	High	7.5	16.7	18.1	23.8	25.7	28.5	34.0	38.7	41.8
	High +LCC	7.5	15.8	18.7	23.9	26.2	28.8	33.4	37.4	39.4
Loheng	Low	5.5	13.4	15.4	16.9	18.0	19.4	22.3	25.0	27.2
	Medium	6.8	15.9	17.9	20.2	21.6	23.5	26.2	28.7	30.8
	High	8.8	18.3	19.9	23.2	24.9	27.3	30.7	33.9	36.6
	High +LCC	8.3	18.7	20.7	23.2	24.8	29.5	32.8	36.6	39.3
Sami	Low	7.7	18.0	20.8	25.4	27.3	30.9	35.9	40.7	44.0
	Medium	7.9	19.3	23.2	28.1	30.2	33.3	36.4	39.6	41.6
	High	8.4	19.5	23.1	28.0	29.8	33.5	37.2	40.7	44.2
	High +LCC	7.2	16.1	19.6	24.7	26.7	30.2	34.6	39.8	42.8
Sidon	Low	9.3	20.8	24.9	28.9	31.2	34.1	37.8	41.7	44.3
	Medium	8.8	20.9	24.1	29.6	31.4	34.8	39.5	43.9	46.9
	High	9.6	22.6	23.3	31.6	33.9	37.2	41.6	45.9	48.0
	High +LCC	8.7	21.4	26.3	31.2	33.8	37.5	42.6	47.7	50.5
Tonil	Low	7.9	19.4	22.3	26.7	28.0	31.0	34.1	36.9	38.8
	Medium	8.8	21.2	23.9	26.9	28.3	31.1	34.4	37.5	39.1
	High	8.6	20.9	24.0	28.1	29.2	31.6	36.1	39.7	42.0
	High +LCC	8.8	21.2	24.7	28.9	31.7	34.9	38.2	42.1	45.2
Doncu	Low	5.4	13.2	15.2	18.5	20.1	22.2	25.2	29.5	31.9
	Medium	8.6	20.1	23.8	29.2	32.0	35.3	38.9	43.7	46.3
	High	8.6	20.7	25.1	28.5	30.7	35.4	40.0	44.4	47.8
	High +LCC	6.2	18.0	20.5	25.6	27.3	31.9	35.3	39.8	43.4
Average	**Low**	**7.3**	**16.9**	**19.8**	**23.5**	**25.3**	**28.1**	**31.9**	**35.8**	**38.5**
	Medium	**8.3**	**19.3**	**22.5**	**26.9**	**29.0**	**32.1**	**36.0**	**39.9**	**42.3**
	High	**8.6**	**19.8**	**22.3**	**27.2**	**29.0**	**32.2**	**36.6**	**40.5**	**43.4**
	High +LCC	**7.8**	**18.5**	**21.8**	**26.3**	**28.4**	**32.1**	**36.1**	**40.6**	**43.4**

Effect of weeding on rubber growth

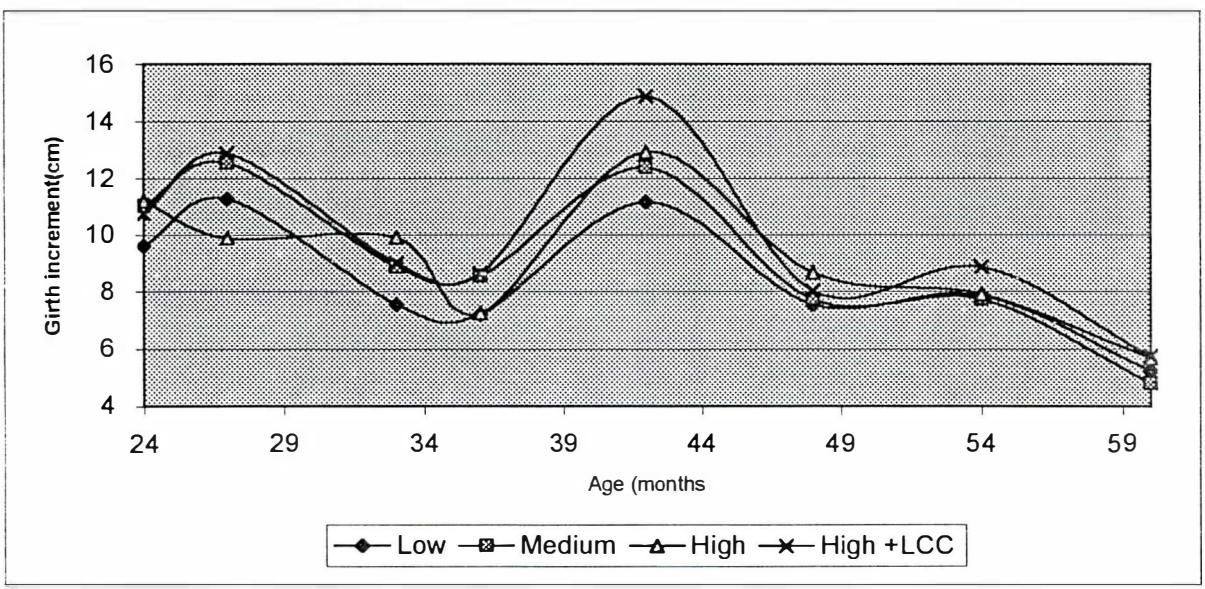


RAS 11 b - WEST KALIMANTAN
Effect of weeding and maintenance on rubber girth increment

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	Feb-01	Nov-01
Latin	Low	8.7	12.4	9.8	10.7	15.1	10.0	10.0	6.7
	Medium	9.7	13.2	11.0	13.1	16.8	11.5	10.5	5.9
	High	9.2	5.6	11.4	7.6	11.2	11.0	9.5	6.1
	High +LCC	8.3	11.6	10.4	9.2	10.3	9.3	7.9	4.1
Loheng	Low	7.9	8.0	3.0	4.4	5.6	5.7	5.4	4.3
	Medium	9.1	8.0	4.6	5.7	7.3	5.5	5.0	4.3
	High	9.5	6.4	6.6	6.6	9.7	6.9	6.3	5.4
	High +LCC	10.4	8.0	5.0	6.4	18.9	6.5	7.7	5.3
Sami	Low	10.3	11.2	9.2	7.5	14.3	10.0	9.6	6.7
	Medium	11.4	15.6	9.8	8.4	12.2	6.2	6.4	4.0
	High	11.1	14.4	9.8	7.1	14.8	7.4	7.0	7.0
	High +LCC	8.9	14.0	10.2	8.0	13.8	8.9	10.4	6.1
Sidon	Low	11.5	16.4	8.0	9.1	11.6	7.5	7.8	5.2
	Medium	12.1	12.8	11.0	7.2	13.6	9.3	8.8	6.1
	High	13.0	2.8	16.6	9.1	13.5	8.7	8.6	4.2
	High +LCC	12.7	19.6	9.8	10.4	14.8	10.1	10.3	5.6
Tonil	Low	11.5	11.6	8.8	5.4	11.7	6.3	5.7	3.6
	Medium	12.4	10.8	6.0	5.5	11.2	6.7	6.2	3.3
	High	12.3	12.4	8.2	4.4	9.6	8.9	7.2	4.7
	High +LCC	12.4	14.0	8.4	11.1	13.0	6.6	7.9	6.2
Doncu	Low	7.8	8.0	6.6	6.2	8.6	5.9	8.7	4.8
	Medium	11.5	14.8	10.8	11.3	13.1	7.1	9.6	5.3
	High	12.1	17.6	6.8	8.8	18.8	9.2	8.8	6.9
	High +LCC	11.8	10.0	10.2	6.8	18.4	6.8	9.1	7.3
Average	**Low**	**9.6**	**11.3**	**7.6**	**7.2**	**11.2**	**7.6**	**7.9**	**5.2**
	Medium	**11.0**	**12.5**	**8.9**	**8.5**	**12.4**	**7.7**	**7.7**	**4.8**
	High	**11.2**	**9.9**	**9.9**	**7.3**	**12.9**	**8.7**	**7.9**	**5.7**
	High +LCC	**10.8**	**12.9**	**9.0**	**8.6**	**14.9**	**8.0**	**8.9**	**5.8**

Effect of weeding on annual girth increment



RAS 11 b - WEST KALIMANTAN
Rubber girth at 60 months

Farmer	Low	Medium	High	High+LCC	Average
Latin	44.6	48.7	41.8	39.4	43.61
Loheng	27.2	30.8	36.6	39.3	33.46
Sami	44.0	41.6	44.2	42.8	43.16
Sidon	44.3	46.9	48.0	50.5	47.44
Tonil	38.8	39.1	42.0	45.2	41.28
Doncu	31.9	46.3	47.8	43.4	42.37
Average	38.46	42.25	43.39	43.45	41.89

Anova: Two-Factor Without Replication

SUMMARY	*Count*	*Sum*	*Average*	*Variance*			
Latin	4	174.46	43.61	15.98			
Loheng	4	133.85	33.46	30.05	**		
Sami	4	172.63	43.16	1.48			
Sidon	4	189.74	47.44	6.59			
Tonil	4	165.11	41.28	8.98			
Doncu	4	169.50	42.37	51.79			
Low	6	230.77	38.46	54.72	*	ssd 5% =	4.98
Medium	6	253.52	42.25	44.10		ssd 1% =	6.88
High	6	260.31	43.39	18.32			
High+LCC	6	260.69	43.45	17.48			

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*	
Rows	427.84	5	85.57	5.233	0.006	2.901	**
Columns	99.31	3	33.10	2.024	0.154	3.287	
Error	245.29	15	16.35				
Total	772.44	23					

RAS 11c -WEST KALIMANTAN

Effect of weeding and maintenance on rubber girth

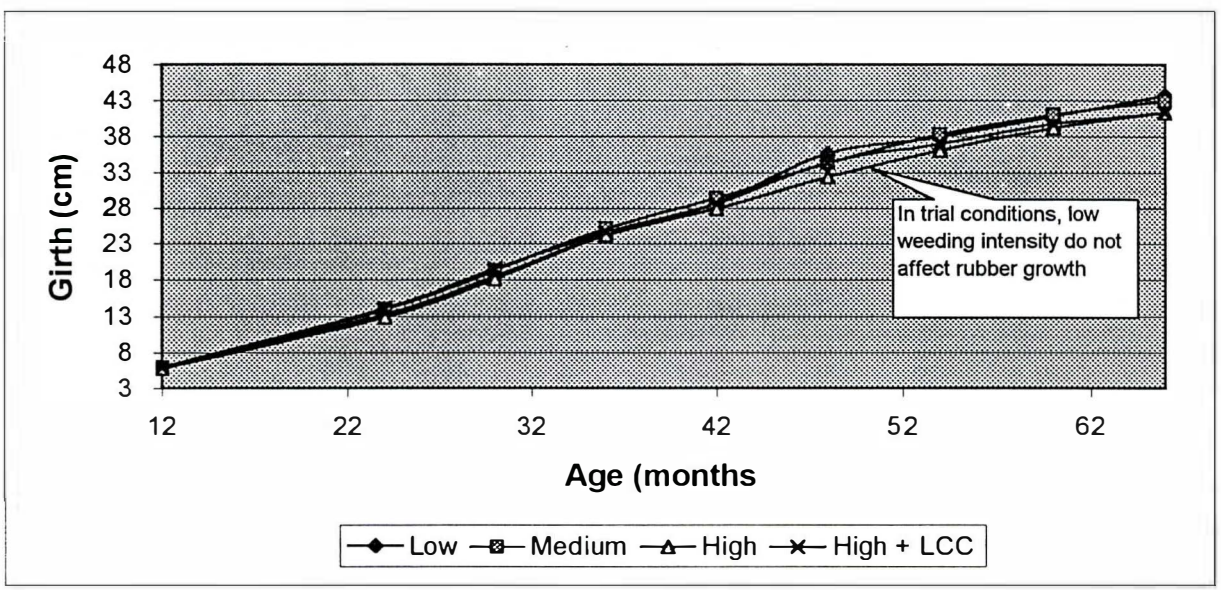
Planting date: February 1996 - Engkayu

Farmer	Weeding Intensity	Girth (cm)									
		Feb-97	Feb-98	Aug-98	Feb-99	Aug-99	Feb-00	Aug-00	Feb-01	Aug-01	
LC Lahon	Low	3.9	5.5	6.5	11.1	15.5	21.5	28.0	32.0	36.3	
	Medium	-	2.9	3.9	5.9	8.8	12.43	15.9	18.1	21.5	(1)
	High	-	1.9	4.6	5.9	8.8	10.22	13.7	16.1	19.2	(1)
	High + LCC	4.3	9.5	12.6	16.9	21.0	25.5	31.5	33.6	37.8	
Six	Low	4.5	9.4	12.9	17.9	22.1	26.2	29.8	31.8	33.8	
	Medium	4.7	9.9	13.4	18.4	22.4	27.5	31.4	33.6	35.5	
	High	4.5	8.2	11.6	16.5	19.4	23.3	27.0	29.4	31.8	
	High + LCC	4.8	10.4	14.4	17.5	22.0	26.1	29.0	30.6	32.6	
Tinus	Low	7.4	17.2	24.0	30.6	35.3	45.1	46.1	49.7	53.6	
	Medium	7.1	18.0	25.1	31.8	36.5	41.1	45.3	48.5	50.3	
	High	7.0	17.5	24.7	31.9	36.4	41.4	45.2	49.0	50.9	
	High + LCC	7.1	17.8	24.6	31.7	35.2	42.8	44.9	48.9	50.0	

(1) Many supplies

Average	**Low**	**6.0**	**13.3**	**18.5**	**24.3**	**28.7**	**35.7**	**38.0**	**40.8**	**43.7**
	Medium	**5.9**	**14.0**	**19.3**	**25.1**	**29.5**	**34.3**	**38.3**	**41.0**	**42.9**
	High	**5.8**	**12.9**	**18.2**	**24.2**	**27.9**	**32.4**	**36.1**	**39.2**	**41.4**
	High + LCC	**6.0**	**14.1**	**19.5**	**24.6**	**28.6**	**34.4**	**36.9**	**39.8**	**41.3**

Effect of weeding on rubber growth



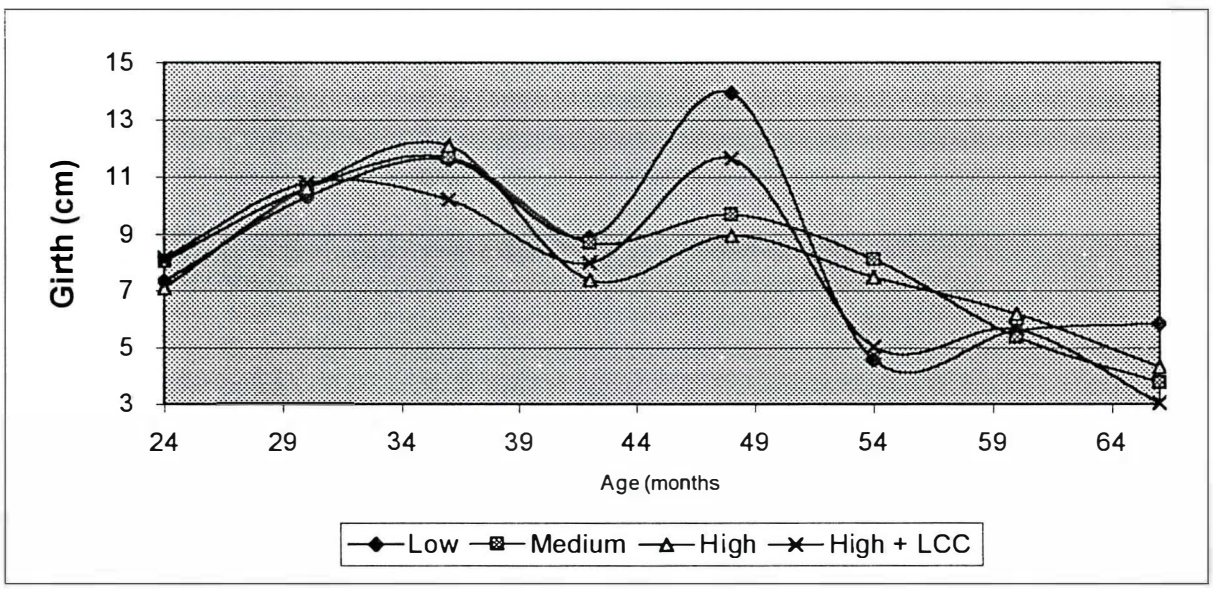
RAS 11c -WEST KALIMANTAN

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	Feb-01	Aug-01
LC Lahong	Low	1.6	2.0	9.2	8.8	12.0	13.0	8.1	8.5
	Medium		2.0	4.0	5.8	7.3	6.9	4.4	6.8
	High		5.4	2.6	5.8	2.8	7.0	4.8	6.1
	High + LCC	5.2	6.2	8.6	8.2	8.9	12.1	4.2	8.4
Six	Low	4.9	7.0	10.0	8.4	8.3	7.2	4.0	4.0
	Medium	5.2	7.0	10.0	8.0	10.1	7.9	4.3	4.0
	High	3.7	6.8	9.8	5.8	7.8	7.4	4.7	4.9
	High + LCC	5.6	8.0	6.2	9.0	8.1	5.8	3.4	4.0
Tinus	Low	9.8	13.6	13.2	9.4	19.6	2.0	7.2	7.7
	Medium	10.9	14.2	13.4	9.4	9.3	8.3	6.5	3.5
	High	10.5	14.4	14.4	9.0	10.0	7.5	7.7	3.8
	High + LCC	10.7	13.6	14.2	7.0	15.2	4.3	8.0	2.1
Average	**Low**	**7.4**	**10.3**	**11.6**	**8.9**	**14.0**	**4.6**	**5.6**	**5.9**
	Medium	**8.1**	**10.6**	**11.7**	**8.7**	**9.7**	**8.1**	**5.4**	**3.8**
	High	**7.1**	**10.6**	**12.1**	**7.4**	**8.9**	**7.5**	**6.2**	**4.3**
	High + LCC	**8.2**	**10.8**	**10.2**	**8.0**	**11.6**	**5.1**	**5.7**	**3.0**

Effect of weeding on rubber growth



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 78 months

Treatments (No of weeding in year 1,2,3)	Girth in cm (%)
Low weeding frequency (0, 4, 4)	34.2 (95)
Medium weeding frequency (1, 6, 6)	34.2 (95)
High weeding frequency (3, 6, 6)	35.9 (100)

No significant differences are observed between treatments. High weeding frequency has increased rubber growth by only 5%! After 6.5 years, rubber trees cannot be tapped yet.

- RAS 1.1b (6 replications): Rubber girth at 60 months

Treatments (No of weeding in year 1,2,3)	Girth in cm (%)
Low weeding frequency (4, 6, 8)	38.5 (89) *
Medium weeding frequency (6, 4, 4)	42.3 (97)
High weeding frequency (8, 6, 6)	43.4 (100)
High weeding frequency (8, 6, 6) + LCC	43.4 (100)

Low intensity weeding obtained slower rubber growth than other treatment (less 10%) and is significantly different of other treatments, 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. The two trials indicated the importance of quality planting material. In trial RAS 11a budded stumps were used. The low maintenance and input regime applied during the 2 first years affected rubber growth and after 6.5 years, trees did not reach yet the standard girth for tapping. On the contrary, in RAS 11b trial, polybag plants were used. Rubber plants had a good growth since the beginning and could be tapped at the age of 5.5 years.

RAS 1.2

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 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 0-10 and 10-20 cm.
- rice production.
- Labor requirement per plot.

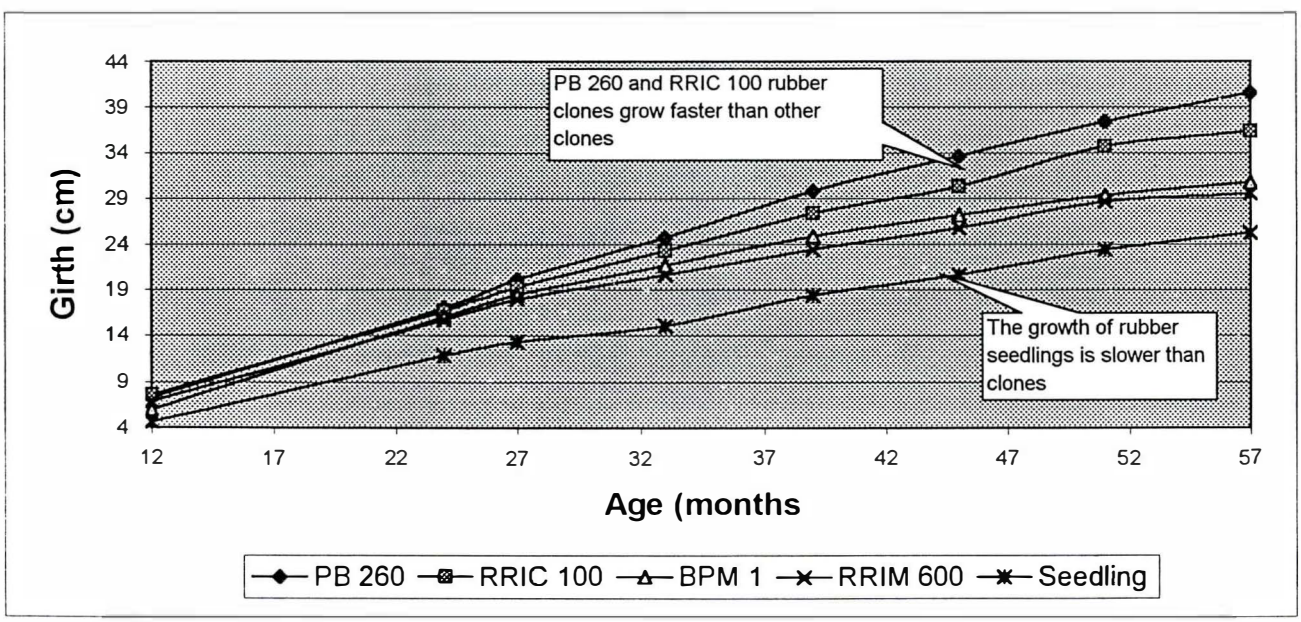
RAS 12a - WEST KALIMANTAN

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	Feb-00	Aug-00	Feb-01	Aug-01	Nov-97	Nov-98	Feb-99	Aug-99	Feb-00	Aug-00	Feb-01	Aug
Aloysius	PB 260	8.1	18.6	21.8	26.3	31.5	35.1	39.5	43.3	9.0	20.6	24.2	30.6	37.1	41.0	46.4	4
	RRIC 100	6.7	15.2	17.5	20.5	23.8	26.0	29.4	31.3	9.2	19.1	21.8	26.4	31.5	35.2	39.7	4
	BPM 1	4.8	11.5	12.6	14.5	15.4	16.5	18.0	19.2	8.3	18.6	20.9	24.0	27.6	29.5	32.9	3
	RRIM 600	6.2	15.4	17.5	20.0	23.8	25.0	28.7	29.9	8.2	17.3	19.4	21.9	25.5	27.7	32.0	3
	Seedling	4.2	12.8	14.2	16.2	18.7	19.9	24.2	26.5	4.3	10.8	12.3	14.2	17.1	18.1	21.4	2
Lidi	PB 260	6.6	16.1	19.2	20.7	26.5	29.3	32.2	33.7	7.4	16.0	18.7	22.1	25.2	28.2	31.5	3
	RRIC 100	6.4	16.3	19.1	22.7	26.5	28.5	31.0	32.3	7.9	17.4	20.6	25.3	28.8	30.8	33.8	3
	BPM 1	6.4	16.3	19.0	22.9	24.7	26.4	27.7	29.0	5.1	14.3	16.6	20.0	22.8	24.5	25.5	2
	RRIM 600	7.7	18.2	20.9	23.7	26.3	28.4	29.1	29.7	5.9	13.3	15.9	17.7	19.2	20.3	21.6	2
	Seedling	6.2	15.2	17.0	18.5	21.5	23.9	25.8	28.1	4.8	12.1	13.6	14.3	17.4	19.4	21.0	2
Jampi 1	PB 260	6.6	15.0	18.5	24.2	28.7	32.4	33.5	38.3	5.3	13.9	16.4	22.1	28.5	31.2	34.0	3
	RRIC 100	6.1	15.6	18.7	24.9	30.9	35.4	40.6	42.3	8.0	17.5	20.3	23.7	29.6	30.9	37.6	3
	BPM 1	7.1	16.3	19.2	23.2	27.2	31.2	34.4	34.8	-	12.4	15.3	17.3	22.2	24.7	26.2	2
	RRIM 600	6.5	15.2	17.2	20.9	23.7	26.2	29.0	29.8	5.9	14.6	17.1	20.3	23.9	26.1	29.4	3
	Seedling	2.8	7.7	8.9	11.1	15.1	17.3	19.4	21.3	2.3	7.2	9.3	12.1	16.2	18.8	21.4	2
Cacot	PB 260	7.9	18.4	21.7	27.1	32.8	38.0	43.4	45.9	7.3	17.6	20.2	24.7	28.8	34.1	38.6	4
	RRIC 100	9.7	16.6	18.4	21.4	24.0	27.8	32.6	34.1	6.7	15.7	17.7	21.3	24.3	28.4	32.7	3
	BPM 1	8.3	19.5	21.9	25.4	29.4	31.9	34.8	36.6	7.7	19.4	22.1	26.0	29.7	33.0	35.5	3
	RRIM 600	6.8	15.4	17.5	19.5	23.0	26.0	30.2	30.9	7.9	16.3	18.2	20.8	21.9	26.3	29.0	2
	Seedling	7.3	15.7	17.3	18.4	24.0	27.1	32.7	34.0	5.3	13.0	14.1	15.5	17.1	20.2	21.3	2
Average	**PB 260**	**7.3**	**17.0**	**20.3**	**24.6**	**29.9**	**33.7**	**37.1**	**40.3**	**7.3**	**17.0**	**19.9**	**24.9**	**29.9**	**33.6**	**37.6**	**40**
	RRIC 100	**7.2**	**15.9**	**18.4**	**22.4**	**26.3**	**29.4**	**33.4**	**35.0**	**8.0**	**17.4**	**20.1**	**24.2**	**28.6**	**31.3**	**36.0**	**37**
	BPM 1	**6.7**	**15.9**	**18.2**	**21.5**	**24.2**	**26.5**	**28.7**	**29.9**	**5.3**	**16.2**	**18.7**	**21.8**	**25.6**	**27.9**	**30.0**	**31**
	RRIM 600	**6.8**	**16.1**	**18.3**	**21.0**	**24.2**	**26.4**	**29.3**	**30.1**	**7.0**	**15.4**	**17.7**	**20.2**	**22.6**	**25.1**	**28.0**	**29**
	Seedling	**5.1**	**12.9**	**14.4**	**16.1**	**19.8**	**22.0**	**25.5**	**27.5**	**4.2**	**10.8**	**12.3**	**14.0**	**17.0**	**19.1**	**21.3**	**22**

Rubber growth according to clone



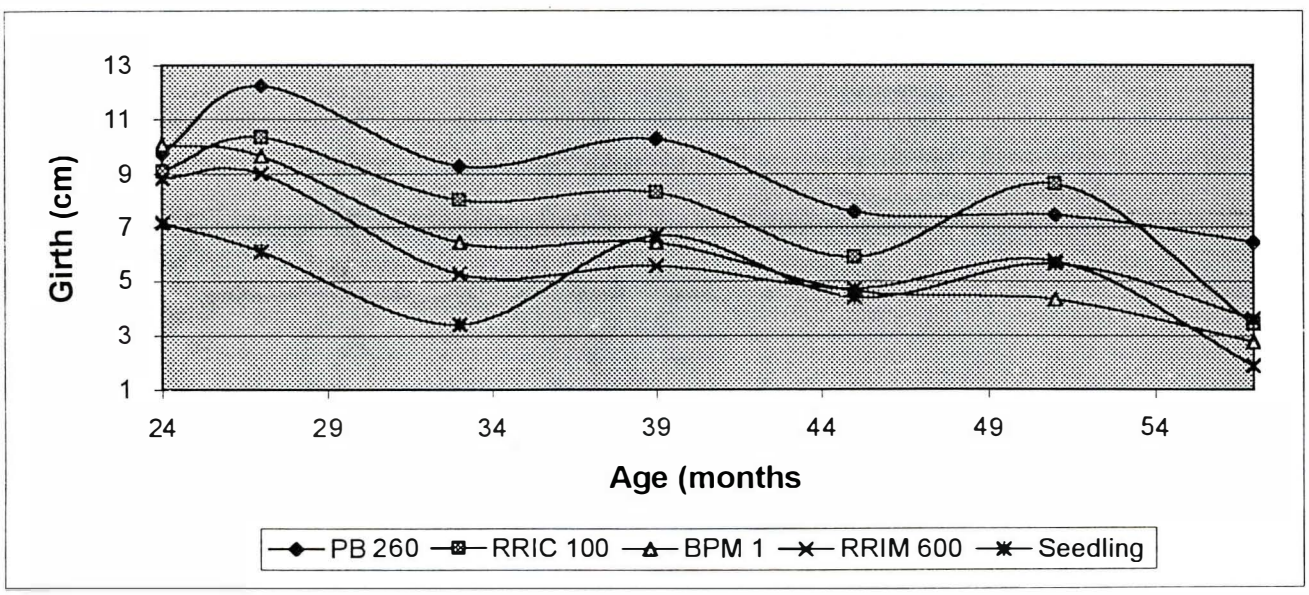
RAS 12a - WEST KALIMANTAN

Annual girth increment of different rubber clones

ng date: November 1996 - Embaong

er	Clone	Girth (cm)													
		Low weeding							High weeding						
		Nov-97	Nov-98	Feb-99	Aug-99	Feb-00	Aug-00	Feb-01	Aug-01	Nov-97	Nov-98	Feb-99	Aug-99	Feb-00	Aug-00	Feb-01	Aug-01
	PB 260		10.5	12.8	9.0	10.4	7.3	8.7	7.6		11.6	14.4	12.8	12.9	7.9	10.7	6.5
	RRIC 100		8.5	9.2	6.0	6.5	4.5	6.8	3.8		9.9	10.8	9.2	10.2	7.4	9.0	6.5
	BPM 1		6.7	4.4	3.8	1.9	2.0	3.1	2.4		10.3	9.2	6.2	7.3	3.7	6.8	2.6
	RRIM 600		9.2	8.4	5.0	7.5	2.5	7.4	2.3		9.1	8.4	5.0	7.2	4.5	8.5	3.2
	Seedling		8.6	5.6	4.0	5.0	2.3	8.6	4.7		6.5	6.0	3.8	5.8	2.1	6.5	4.5
	PB 260		9.5	12.4	3.0	11.6	5.6	5.8	2.9		8.6	10.8	6.8	6.3	5.9	6.6	3.2
	RRIC 100		9.9	11.2	7.2	7.6	4.0	5.1	2.4		9.5	12.8	9.4	7.0	4.1	6.0	2.1
	BPM 1		9.9	10.8	7.8	3.5	3.4	2.6	2.6		9.2	9.2	6.8	5.6	3.4	2.0	2.8
	RRIM 600		10.5	10.8	5.6	5.2	4.2	1.4	1.3		7.4	10.4	3.6	3.0	2.3	2.5	1.5
	Seedling		9.0	7.2	3.0	6.0	4.8	3.9	4.6		7.3	6.0	1.4	6.3	4.0	3.1	4.4
	PB 260		8.4	14.0	11.4	9.0	7.4	2.1	9.7		8.6	10.0	11.4	12.7	5.6	5.5	11.3
	RRIC 100		9.5	12.4	12.4	12.1	9.0	10.2	3.5		9.5	11.2	6.8	11.9	2.5	13.4	3.0
	BPM 1		9.2	11.6	8.0	8.1	8.0	6.3	0.8		12.4	11.6	4.0	9.8	4.9	3.1	3.6
	RRIM 600		8.7	8.0	7.4	5.6	5.0	5.7	1.5		8.7	10.0	6.4	7.2	4.5	6.6	2.4
	Seedling		4.9	4.8	4.4	8.0	4.4	4.3	3.8		4.9	8.4	5.6	8.2	5.1	5.3	2.6
	PB 260		10.5	13.2	10.8	11.4	10.3	10.9	5.0		10.3	10.4	9.0	8.2	10.6	9.1	5.3
	RRIC 100		6.9	7.2	6.0	5.3	7.5	9.6	3.1		9.0	8.0	7.2	6.1	8.1	8.7	2.8
	BPM 1		11.2	9.6	7.0	8.0	5.1	5.7	3.7		11.7	10.8	7.8	7.4	6.7	4.9	3.4
	RRIM 600		8.6	8.4	4.0	6.9	6.0	8.4	1.4		8.4	7.6	5.2	2.2	8.8	5.4	1.5
	Seedling		8.4	6.4	2.2	11.1	6.2	11.3	2.7		7.7	4.4	2.8	3.2	6.2	2.2	1.7
e	**PB 260**		**9.7**	**13.1**	**8.6**	**10.6**	**7.7**	**6.9**	**6.3**		**9.8**	**11.4**	**10.0**	**10.0**	**7.5**	**8.0**	**6.6**
	RRIC 100		**8.7**	**10.0**	**7.9**	**7.9**	**6.2**	**7.9**	**3.2**		**9.5**	**10.7**	**8.2**	**8.8**	**5.5**	**9.3**	**3.6**
	BPM 1		**9.3**	**9.1**	**6.7**	**5.4**	**4.6**	**4.4**	**2.4**		**10.9**	**10.2**	**6.2**	**7.5**	**4.7**	**4.2**	**3.1**
	RRIM 600		**9.3**	**8.9**	**5.5**	**6.3**	**4.5**	**5.7**	**1.6**		**8.4**	**9.1**	**5.1**	**4.9**	**5.0**	**5.8**	**2.2**
	Seedling		**7.7**	**6.0**	**3.4**	**7.5**	**4.4**	**7.0**	**3.9**		**6.6**	**6.2**	**3.4**	**5.9**	**4.3**	**4.3**	**3.3**

Annual girth increment according to rubber clone



RAS 12a - WEST KALIMANTAN
Rubber girth at 57 months

	PB 260	RRIC 100	BPM 1	RRIM 600	Seedling
Aloysius	46.48	37.13	26.71	31.72	25.09
Lidi	33.36	33.57	27.94	26.03	25.67
Jampi 1	38.98	40.71	31.39	30.21	22.01
Cacot	43.58	34.10	36.92	30.30	28.10
Average	40.60	36.38	30.74	29.57	25.22

Anova: Two-Factor Without Replication

SUMMARY	*Count*	*Sum*	*Average*	*Variance*		
Aloysius	5	167.12	33.42	75.39		
Lidi	5	146.57	29.31	15.11		
Jampi 1	5	163.30	32.66	56.46		
Cacot	5	173.00	34.60	36.73		
PB 260	4	162.40	40.60	32.83		
RRIC 100	4	145.51	36.38	10.79		
BPM 1	4	122.96	30.74	20.89	lsd 5% =	5.51
RRIM 600	4	118.27	29.57	6.03	lsd 1% =	7.72
Seedling	4	100.86	25.22	6.29		

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*	
Farmer	77.24	3	25.746	2.016	0.165	3.490	
Rubber clone	581.54	4	145.384	11.385	0.000	3.259	**
Error	153.24	12	12.770				
Total	812.02	19					

PB 260	40.60	
RRIC 100	36.38	
RRIM 600	30.74	ab
BPM 1	29.57	ab
Seedling	25.22	abcd

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

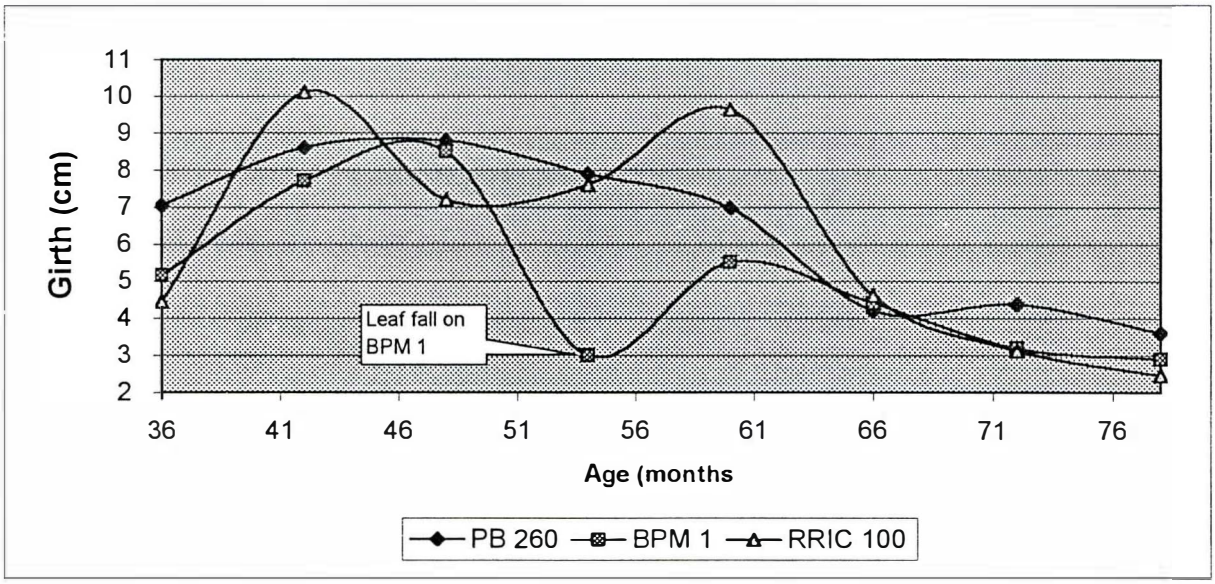
RAS 12b -WEST KALIMANTAN

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	Feb-01	Aug-01
Gabriel 1	PB 260		9.4	7.8	13.4	7.6	8.4	4.5	4.4	2.6
	BPM 1		3.5	8.8	8.0	1.8	5.9	4.9	3.2	3.8
	RRIC 100		2.5	11.0	7.8	8.6	8.1	3.9	0.9	1.8
Gabriel 2	PB 260		4.7	9.4	4.2	8.2	5.6	3.9	4.4	4.7
	BPM 1		6.8	6.6	9.0	4.2	5.2	3.9	3.2	2.0
	RRIC 100		6.4	9.2	6.6	6.6	11.2	5.3	5.3	3.1
Average	**PB 260**		**7.1**	**8.6**	**8.8**	**7.9**	**7.0**	**4.2**	**4.4**	**3.6**
	BPM 1		**5.2**	**7.7**	**8.5**	**3.0**	**5.5**	**4.4**	**3.2**	**2.9**
	RRIC 100		**4.5**	**10.1**	**7.2**	**7.6**	**9.6**	**4.6**	**3.1**	**2.5**

Annual girth increment of different clones



RAS 12b -WEST KALIMANTAN

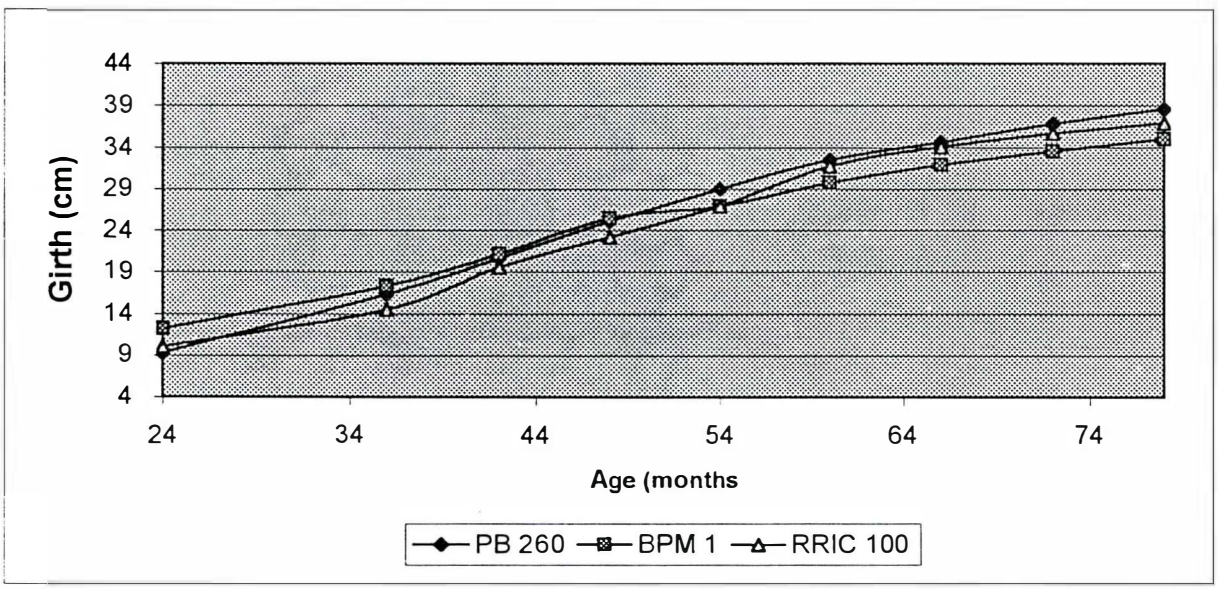
Performances of different rubber clones in near jungle rubber environment (RAS1)

Planting date: February 1995 - Engkayu 1

Farmer	Clone	Girth (cm)								
		Feb-97	Feb-98	Aug-98	Feb-99	Aug-99	Feb-00	Aug-00	Feb-01	Aug-01
Gabriel rep1	PB 260	9.9	19.3	23.2	29.9	33.7	37.9	40.2	42.3	43.6
	BPM 1	13.9	17.4	21.8	25.8	26.7	29.6	32.1	33.7	35.6
	RRIC 100	10.3	12.8	18.3	22.2	26.5	30.6	32.5	33.0	33.9
Gabriel rep2	PB 260	8.7	13.4	18.1	20.2	24.3	27.1	29.0	31.2	33.6
	BPM 1	10.5	17.3	20.6	25.1	27.2	29.8	31.8	33.3	34.3
	RRIC 100	9.8	16.2	20.8	24.1	27.4	33.0	35.6	38.3	39.9

Average	**PB 260**	**9.3**	**16.4**	**20.7**	**25.1**	**29.0**	**32.5**	**34.6**	**36.8**	**38.6**
	BPM 1	**12.2**	**17.4**	**21.2**	**25.5**	**27.0**	**29.7**	**31.9**	**33.5**	**35.0**
	RRIC 100	**10.1**	**14.5**	**19.6**	**23.2**	**27.0**	**31.8**	**34.1**	**35.6**	**36.9**

Rubber growth according to clone



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 57 months

Treatments	Girth in cm (%)
PB 260	40.6 (100) a
RRIC 100	36.4 (90) a
BPM 1	30.7 (76) b
RRIM 600	29.6 (73) b
Clonal seedlings	25.2 (62) 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 78 months

Treatments	Girth in cm (%)
PB 260	38.6 (100)
BPM 1	35.0 (91)
RRIC 100	36.9 (96)

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 performed well in RAS 1 conditions and they outperformed 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.

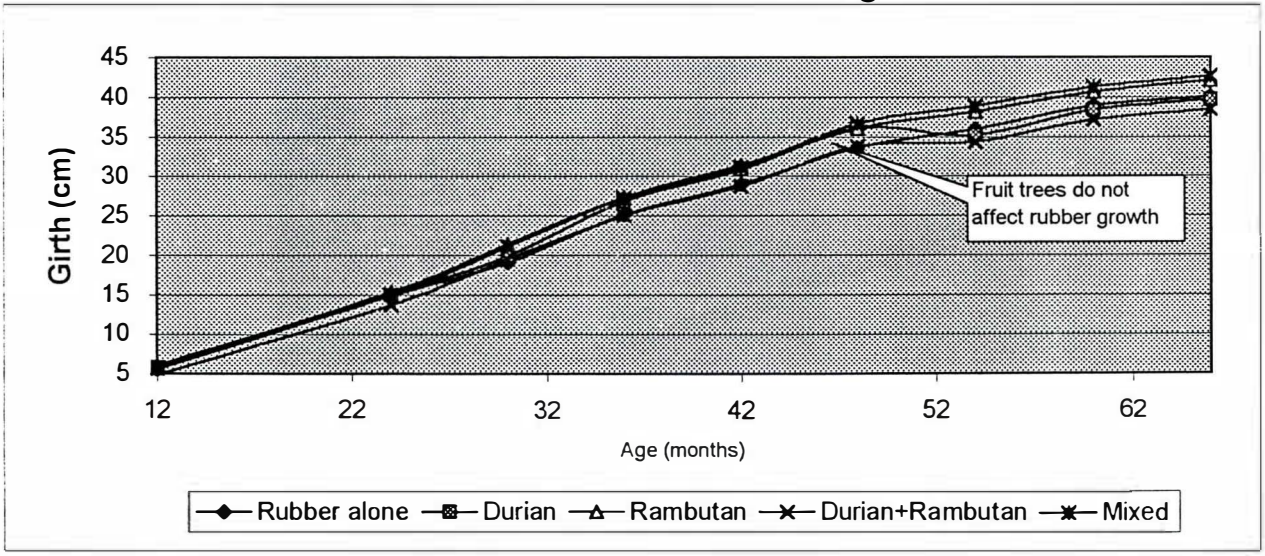
RAS 21a - WEST KALIMANTAN
Effect of fruit trees intercropping on rubber girth

Planting February 1996 - Trimulia

Farmer	Plot	Associated Trees	Girth (cm)									
			Feb-97	Feb-98	Aug-98	Feb-99	Aug-99	Feb-00	Aug-00	Feb-01	Aug-01	
Marjo	A	Rubber	3.5	10.4	16.1	22.6	26.4	30.3	33.0	35.6	36.2	
	B	Durian	3.0	8.1	12.8	19.8	23.7	29.1	30.6	35.3	37.0	
	C	Rambutan	4.9	15.6	21.9	28.6	32.5	36.3	37.4	39.6	40.7	
	D	Durian+Rambutan	3.9	12.4	19.7	23.5	26.8	30.7	32.0	35.1	35.8	
	E	Mixed	2.0	9.0	14.1	19.6	23.0	28.3	30.7	33.5	34.7	
Yasdi	A	Rubber	6.7	17.7	24.6	31.0	34.6	39.7	43.4	46.6	46.7	
	B	Durian	7.9	18.1	24.1	30.3	34.2	38.6	41.0	42.9	43.5	
	C	Rambutan	7.7	17.3	23.5	29.5	32.8	38.3	40.1	43.8	44.7	
	D	Durian+Rambutan	7.2	17.3	23.5	28.3	32.4	37.5	42.0	43.8	44.4	
	E	Mixed trees	7.3	18.9	25.6	32.1	36.3	41.3	43.4	45.5	45.8	
Sardi	A	Rubber	4.2	14.4	20.5	25.7	29.8	34.0	36.4	40.5	41.4	
	B	Durian	3.1	3.2	7.4	11.1	13.5	17.0	20.9	25.5	26.8	fire
	C	Rambutan	4.7	11.1	17.3	22.6	27.2	31.6	35.4	38.5	41.4	
	D	Durian+Rambutan	4.3	4.9	9.9	14.0	17.5	21.7	24.6	28.7	30.3	fire
	E	Mixed trees	4.3	12.1	18.3	23.6	27.8	32.9	35.3	39.1	40.1	
Priyo	A	Rubber	5.8	12.7	12.0	17.4	21.0	25.5	26.7	29.1	30.9	
	B	Durian	4.9	13.6	15.2	21.9	25.7	31.5	33.4	35.5	36.8	
	C	Rambutan	4.2	10.1	14.8	20.5	24.3	29.3	32.1	33.9	35.6	
	D	Durian+Rambutan	3.7	10.1	14.8	19.5	22.7	28.0	30.0	31.9	33.1	
	E	Mixed trees	6.4	12.9	18.1	24.5	28.4	33.4	36.4	38.1	39.8	
Sadianto	A	Rubber	7.1	15.7	21.8	28.5	32.8	38.5	39.4	43.4	44.8	
	B	Durian	7.9	18.4	24.5	32.0	35.6	40.9	42.0	44.9	46.1	
	C	Rambutan	7.3	18.0	25.0	31.2	34.8	39.3	39.7	42.7	43.8	
	D	Durian+Rambutan	4.0	13.0	17.2	25.5	29.1	34.8	36.8	39.6	42.4	
	E	Mixed trees	7.8	19.5	26.3	33.3	37.4	42.9	43.9	46.0	48.1	
Poniman	A	Rubber	6.1	17.9	19.3	25.3	29.0	33.6	36.6	38.5	40.3	
	B	Durian	5.4	16.2	22.8	29.8	34.8	40.1	43.4	46.2	47.6	
	C	Rambutan	7.7	19.9	25.8	31.8	36.7	41.2	44.0	45.4	46.4	
	D	Durian+Rambutan	5.4	15.5	21.7	28.0	32.5	37.7	40.6	43.5	44.6	
	E	Mixed trees	6.0	17.4	23.8	30.5	33.9	41.3	43.6	45.4	47.3	

Average	**A**	**Rubber**	**5.6**	**14.8**	**19.0**	**25.1**	**28.9**	**33.6**	**35.9**	**39.0**	**40.0**
	B	**Durian**	**5.8**	**14.9**	**19.9**	**26.8**	**30.8**	**36.0**	**35.2**	**38.4**	**39.6**
	C	**Rambutan**	**6.1**	**15.3**	**21.4**	**27.4**	**31.4**	**36.0**	**38.1**	**40.7**	**42.1**
	D	**Durian+Rambutan**	**4.8**	**13.7**	**19.4**	**25.0**	**28.7**	**33.8**	**34.3**	**37.1**	**38.4**
	E	**Mixed trees**	**5.6**	**15.0**	**21.0**	**27.3**	**31.1**	**36.7**	**38.9**	**41.3**	**42.6**

Effect of associated trees on rubber growth



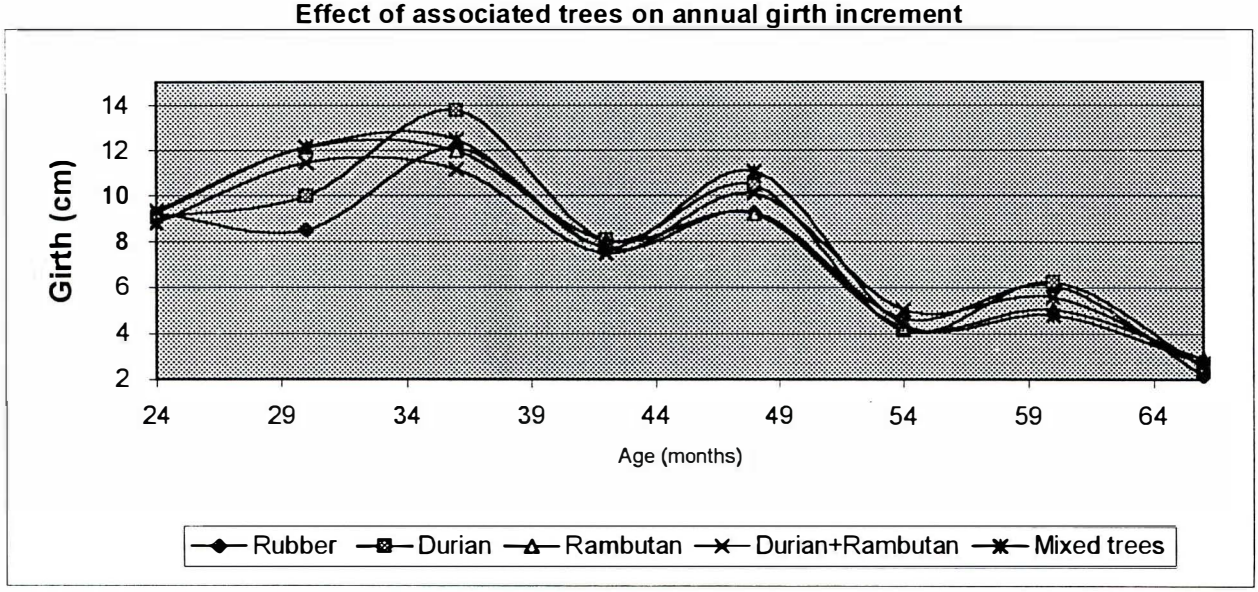
RAS 21a - WEST KALIMANTAN
Effect of fruit trees intercropping on annual rubber girth increment

Planting February 1996 - TRIMULYA

Farmer	Plot	Associated Trees	Girth (cm)							
			Feb-97	Feb-98	Aug-98	Feb-99	Aug-99	Feb-00	Aug-00	Feb-01	Aug-01
Marjo	A	Rubber	6.9	11.4	13.0	7.6	7.8	5.4	5.2	1.1
	B	Durian	5.1	9.4	14.0	7.8	10.8	3.0	9.4	3.3
	C	Rambutan	10.7	12.7	13.4	7.8	7.6	2.3	4.3	2.1
	D	Durian+Rambutan	8.5	14.6	7.6	6.6	7.9	2.5	6.3	1.4
	E	Mixed trees	7.0	10.2	11.0	6.8	10.6	4.8	5.6	2.4
Yasdi	A	Rubber	11.0	13.8	12.8	7.2	10.1	7.4	6.4	0.2
	B	Durian	10.2	12.0	12.4	7.8	8.8	4.8	3.7	1.3
	C	Rambutan	9.6	12.4	12.0	6.6	11.0	3.7	7.4	1.8
	D	Durian+Rambutan	10.1	12.4	9.6	8.2	10.2	8.9	3.6	1.2
	E	Mixed trees	11.6	13.4	13.0	8.4	10.0	4.3	4.2	0.6
Sardi	A	Rubber	10.2	12.2	10.4	8.2	8.3	4.9	8.2	1.8
	B	Durian	0.1	8.4	7.4	4.8	7.0	7.8	9.2	2.5
	C	Rambutan	6.4	12.4	10.6	9.2	8.8	7.6	6.3	5.9
	D	Durian+Rambutan	0.6	10.0	8.2	7.0	8.3	5.8	8.3	3.2
	E	Mixed trees	7.8	12.4	10.6	8.4	10.2	4.8	7.6	2.0
Priyo	A	Rubber	6.9	(1.4)	10.8	7.2	9.0	2.3	4.9	3.6
	B	Durian	8.7	3.1	13.5	7.6	11.5	3.9	4.1	2.7
	C	Rambutan	5.9	9.4	11.4	7.6	10.0	5.6	3.6	3.5
	D	Durian+Rambutan	6.4	9.4	9.4	6.4	10.6	4.0	3.8	2.5
	E	Mixed trees	6.5	10.4	12.8	7.8	9.9	6.1	3.3	3.5
Sadianto	A	Rubber	8.6	12.2	13.4	8.6	11.3	1.9	8.0	2.7
	B	Durian	10.5	12.2	15.0	7.2	10.6	2.2	5.7	2.6
	C	Rambutan	10.7	14.1	12.4	7.2	9.0	0.8	6.0	2.1
	D	Durian+Rambutan	9.0	8.4	16.6	7.2	11.5	4.0	5.5	5.5
	E	Mixed trees	11.7	13.6	14.0	8.2	11.0	1.9	4.3	4.1
Poniman	A	Rubber	11.8	2.8	12.0	7.4	9.1	6.1	3.8	3.6
	B	Durian	10.8	13.2	14.0	10.0	10.6	6.7	5.5	2.9
	C	Rambutan	12.2	11.8	12.0	9.8	9.0	5.6	2.8	1.9
	D	Durian+Rambutan	10.1	12.4	12.6	9.0	10.4	5.7	6.0	2.2
	E	Mixed trees	11.4	12.8	13.4	6.8	14.8	4.5	3.8	3.7

Average	**A**	**Rubber**	**9.2**	**8.5**	**12.1**	**7.7**	**9.3**	**4.7**	**6.1**	**2.2**
	B	**Durian**	**9.1**	**10.0**	**13.8**	**8.1**	**10.5**	**4.1**	**6.3**	**2.6**
	C	**Rambutan**	**9.2**	**12.1**	**12.0**	**8.0**	**9.2**	**4.3**	**5.1**	**2.9**
	D	**Durian+Rambutan**	**8.8**	**11.4**	**11.2**	**7.5**	**10.1**	**5.0**	**5.6**	**2.7**
	E	**Mixed trees**	**9.3**	**12.1**	**12.5**	**7.7**	**11.1**	**4.4**	**4.8**	**2.7**

Effect of associated trees on annual girth increment



RAS 21a - WEST KALIMANTAN
Rubber girth at 66 months
in intercropped plots

Farmer	Rubber	Durian	Rambutan	Dur+Ramb	Mixed	Average
Marjo	36.2	37.0	40.7	35.8	34.7	36.9
Yasdi	46.7	43.5	44.7	44.4	45.8	45.0
Priyo	30.9	36.8	35.6	33.1	39.8	35.3
Sadianto	44.8	46.1	43.8	42.4	48.1	45.0
Poniman	40.3	47.6	46.4	44.6	47.3	45.2
Average	39.6	40.9	41.2	38.9	42.1	40.5

Anova: Two-Factor Without Replication

SUMMARY	*Count*	*Sum*	*Average*	*Variance*
Marjo	5	184.31	36.86	5.16
Yasdi	5	225.12	45.02	1.56
Priyo	5	176.30	35.26	11.69
Sadianto	5	225.14	45.03	4.81
Poniman	5	226.17	45.23	9.01
Rubber	5	198.85	39.77	41.33
Durian	5	211.05	42.21	25.73
Rambutan	5	211.11	42.22	17.97
Dur+Ramb	5	200.32	40.06	27.62
Mixed	5	215.70	43.14	32.68

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*	
Farmer	496.30	4	124.08	23.345	0.000	3.007	**
Assoc. trees	43.86	4	10.96	2.063	0.134	3.007	
Error	85.04	16	5.31				
Total	625.20	24					

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 66 months

Treatments	Girth in cm (%)
Rubber alone	39.6 (100)
Rubber with Durian	40.9 (103)
Rubber with Rambutan	41.2 (104)
Rubber with Durian & Rambutan	38.9 (98)
Rubber with Mixed trees	42.1 (106)

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 from banana would be more appropriate to generate some production before 5 years.

RAS 2.2

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.

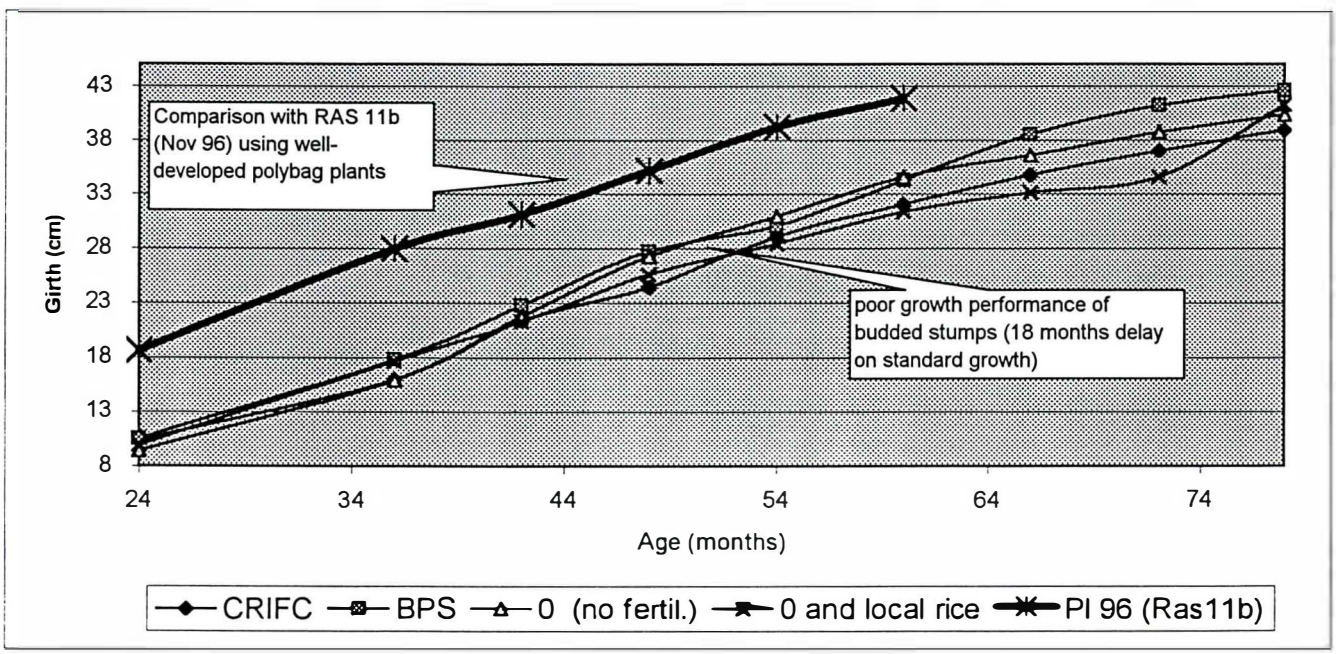
In Trimulia and SPP Karya : if there is intercropping on the total surface of the field, including the rubber row : no use of herbicide. `

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	Feb-01	Aug-01
Andreas	A	CRIFC	13.2	20.6	26.0	27.3	34.4	36.9	39.6	41.3	42.3
	B	BPS	12.8	22.1	26.9	31.8	33.9	37.1	38.7	41.3	42.6
	C	0 (no fertil.)	15.0	23.4	29.8	35.2	38.0	39.5	40.9	42.2	43.7
	D	0 and local rice	12.1	22.1	27.9	33.6	37.1	39.6	40.1	40.5	43.2
Muksin	A	CRIFC	9.0	15.2	19.4	23.2	29.2	30.8	31.9	34.5	
	B	BPS	8.6	15.8	18.2	26.4	28.3	32.6	36.3	40.1	
	C	0 (no fertil.)	6.3	12.8	19.6	25.8	29.7	33.7	35.6	38.2	
	D	0 and local rice	5.8	12.0	12.7	14.4	15.7	16.7	17.9	18.7	
Garmin	A	CRIFC	7.6	13.0	20.2	23.8	27.3	30.8	34.3	35.8	36.8
	B	BPS	8.0	13.9	22.7	24.8	27.5	32.6	35.8	38.0	38.8
	C	0 (no fertil.)	5.8	11.7	17.4	23.8	27.5	31.2	34.3	36.2	37.4
	D	0 and local rice	9.0	14.9	21.8	27.0	30.0	33.7	37.0	38.9	39.5
Gabriel 2	A	CRIFC	11.6	15.1	19.8	23.4	25.5	29.6	33.2	36.4	37.6
	B	BPS	12.8	19.5	23.1	27.8	30.8	34.7	43.3	45.6	46.3
	C	0 (no fertil.)	10.6	15.8	20.2	24.1	28.6	33.7	35.5	38.3	39.9
	D	0 and local rice	12.9	21.4	22.7	27.3	30.8	35.5	37.5	40.1	41.1
Average	**A**	**CRIFC**	**10.4**	**16.0**	**21.3**	**24.4**	**29.1**	**32.0**	**34.7**	**37.0**	**38.9**
	B	**BPS**	**10.6**	**17.8**	**22.7**	**27.7**	**30.1**	**34.2**	**38.5**	**41.2**	**42.6**
	C	**0 (no fertil.)**	**9.4**	**15.9**	**21.7**	**27.2**	**31.0**	**34.5**	**36.5**	**38.7**	**40.3**
	D	**0 and local rice**	**10.0**	**17.6**	**21.3**	**25.6**	**28.4**	**31.4**	**33.1**	**34.5**	**41.3**

Effect of upland rice cultivation on rubber growth

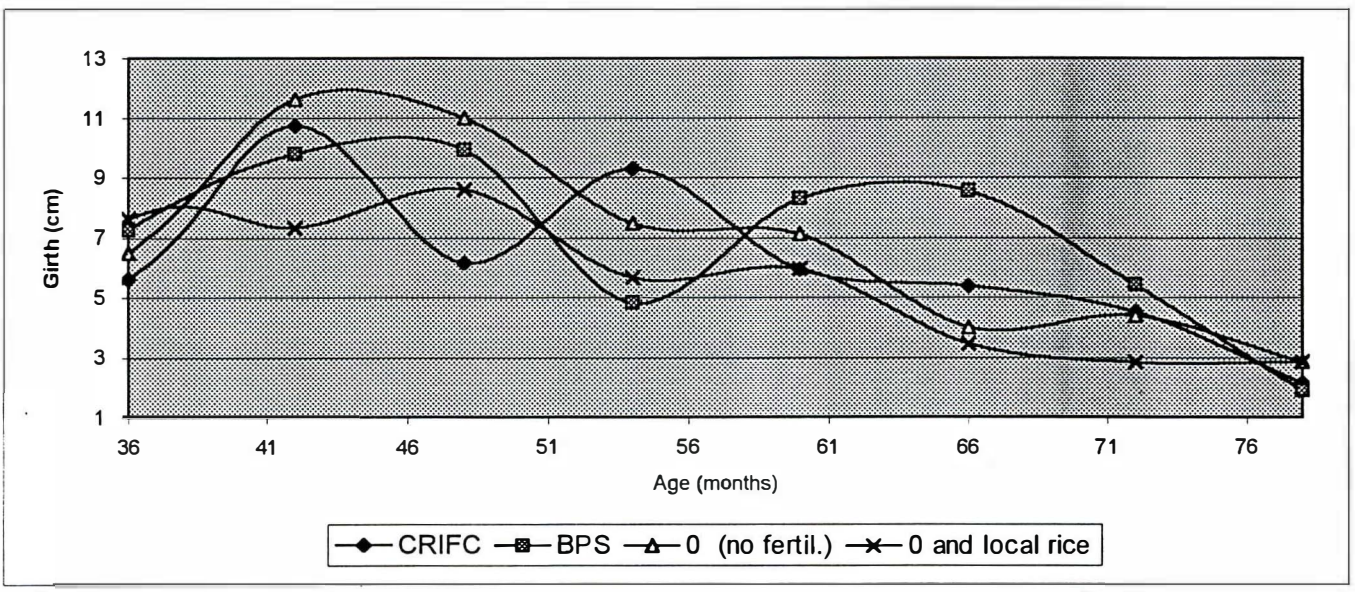


RAS 22 a - WEST KALIMANTAN
Residual effect of rice cultivation on annual girth increment of rubber

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	Feb-01	Aug-01
Andreas	A	CRIFC		7.4	10.7	2.6	14.2	5.1	5.3	3.4	1.9
	B	BPS		9.3	9.5	9.9	4.1	6.6	3.1	5.1	2.6
	C	0 (no fertil.)		8.4	12.8	10.8	5.6	2.9	2.8	2.5	3.0
	D	0 and local rice		10.0	11.6	11.5	7.0	5.0	0.9	0.8	5.4
Muksin	A	CRIFC		6.2	8.5	7.5	12.0	3.3	2.1	5.2	
	B	BPS		7.2	4.8	16.3	3.8	8.6	7.3	7.7	
	C	0 (no fertil.)		6.5	13.6	12.5	7.8	8.1	3.6	5.3	
	D	0 and local rice		6.2	1.3	3.3	2.7	1.9	2.5	1.5	
Garmin	A	CRIFC		5.4	14.4	7.3	6.9	7.1	7.0	3.0	2.0
	B	BPS		5.9	17.6	4.2	5.3	10.3	6.5	4.3	1.6
	C	0 (no fertil.)		5.9	11.4	12.8	7.5	7.4	6.0	4.0	2.4
	D	0 and local rice		5.9	13.8	10.4	5.9	7.5	6.5	3.8	1.2
Gabriel 2	A	CRIFC		3.5	9.3	7.2	4.2	8.2	7.1	6.4	2.6
	B	BPS		6.7	7.3	9.3	6.0	7.7	17.3	4.6	1.5
	C	0 (no fertil.)		5.3	8.7	7.9	9.0	10.1	3.6	5.8	3.2
	D	0 and local rice		8.5	2.7	9.2	7.0	9.5	3.9	5.3	2.0
Average	**A**	**CRIFC**		**5.6**	**10.7**	**6.2**	**9.3**	**5.9**	**5.4**	**4.5**	**2.2**
	B	**BPS**		**7.3**	**9.8**	**9.9**	**4.8**	**8.3**	**8.6**	**5.4**	**1.9**
	C	**0 (no fertil.)**		**6.5**	**11.6**	**11.0**	**7.5**	**7.1**	**4.0**	**4.4**	**2.9**
	D	**0 and local rice**		**7.6**	**7.3**	**8.6**	**5.7**	**6.0**	**3.5**	**2.8**	**2.9**

Effect of upland rice cultivation on annual girth increment



RAS 22 a - WEST KALIMANTAN
Rubber girth at 72 months
in upland rice intercropped plots

	Different fertilizer schemes on upland rice			
Farmer	CRIFC	BPS	0 (no fertil.)	0 & local rice
Andreas	41.3	41.3	42.2	40.5
Muksin	34.5	40.1	38.2	18.7
Garmin	35.8	38.0	36.2	38.9
Gabriel 2	36.4	45.6	38.3	40.1
Average	37.0	41.2	38.7	34.5

Anova: Two-Factor Without Replication

SUMMARY	*Count*	*Sum*	*Average*	*Variance*
Andreas	4	165.20	41.30	0.48
Muksin	4	131.42	32.86	94.97
Garmin	4	148.91	37.23	2.06
Gabriel 2	4	160.42	40.11	15.80
CRIFC	4	147.97	36.99	8.88
BPS	4	164.92	41.23	10.34
0 (no fertil.)	4	154.93	38.73	6.14
0 & local rice	4	138.13	34.53	112.47

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Farmer	169.27	3	56.425	2.079	0.173	3.863
Fertilizer scheme	95.72	3	31.905	1.176	0.372	3.863
Error	244.22	9	27.136			
Total	509.21	15				

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

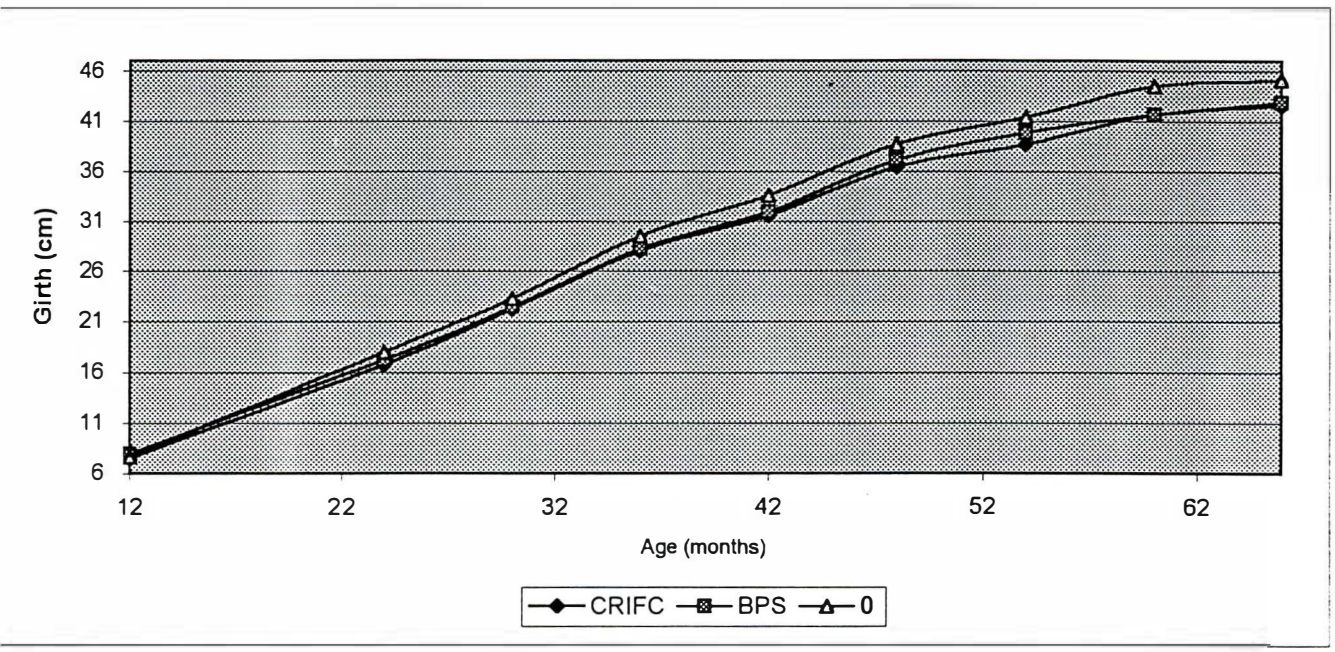
Planting February 1996 TRIMULYA

Farmer	Plot	Fertilization scheme for upland rice	Girth (cm)								
			Feb-97	Feb-98	Aug-98	Feb-99	Aug-99	Feb-00	Aug-00	Feb-01	Aug-01
Raji	A	CRIFC	9.5	17.1	21.8	28.4	32.1	36.7	39.7	42.2	43.4
	C	BPS	8.4	15.2	19.8	25.8	29.0	33.1	36.4	38.0	38.8
	E	0	7.7	16.8	20.5	28.4	31.6	35.8	38.3	40.9	42.2
Ponimin	A	CRIFC	4.9	14.1	20.6	26.5	29.9	34.5	36.8	40.1	41.2
	C	BPS	-	4.4	9.2	12.6	15.4	18.9	22.3	27.0	29.3 (1)
	E	0	5.3	15.7	22.6	28.2	32.5	38.0	41.0	44.8	45.0
Suwito	A	CRIFC	8.1	19.1	24.4	29.3	32.6	38.1	39.7	42.6	43.1
	C	BPS	7.6	19.4	25.2	30.8	34.9	41.2	43.4	45.3	47.0
	E	0	9.9	21.5	26.8	32.1	36.7	42.5	44.9	47.7	48.0

(1) Supplies after fire

Average											
	A	**CRIFC**	**7.5**	**16.7**	**22.2**	**28.0**	**31.5**	**36.4**	**38.7**	**41.6**	**42.6**
	C	**BPS**	**8.0**	**17.3**	**22.5**	**28.3**	**31.9**	**37.1**	**39.9**	**41.6**	**42.9**
	E	**0**	**7.6**	**18.0**	**23.3**	**29.5**	**33.6**	**38.7**	**41.4**	**44.4**	**45.1**

Effect of upland rice cultivation on rubber growth



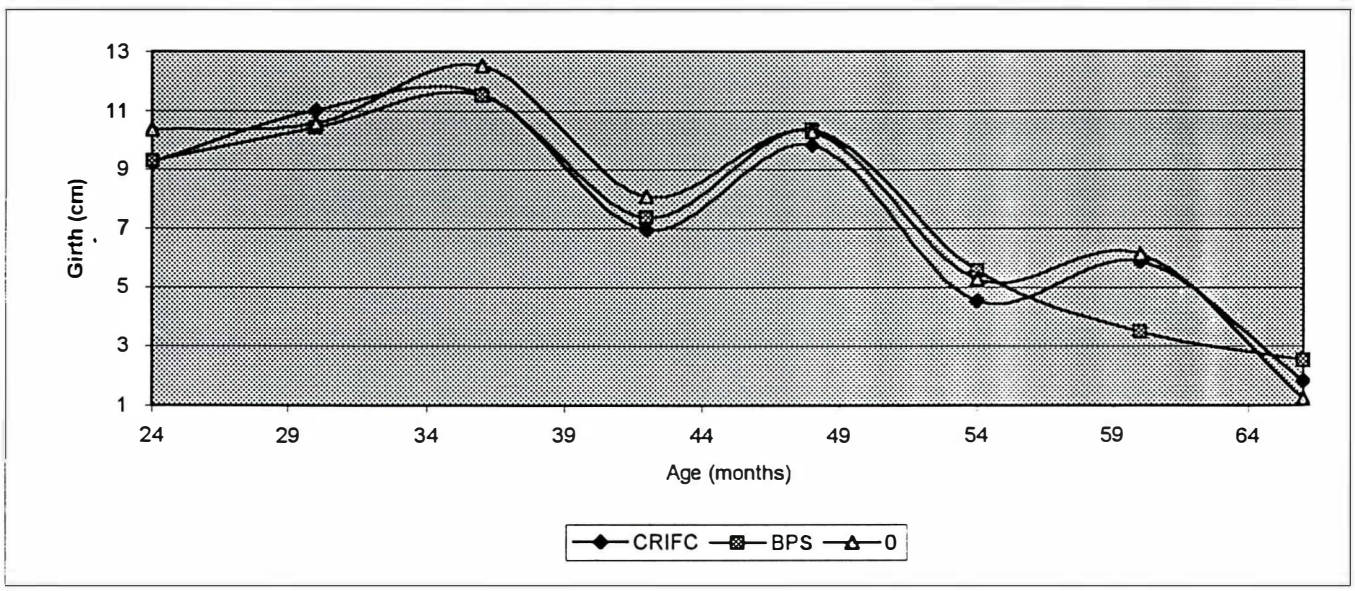
RAS 22 b - WEST KALIMANTAN
Residual effect of rice cultivation on annual girth increment of rubber

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	Feb-01	Aug-01
Raji	A	CRIFC	7.6	9.3	13.2	7.5	9.3	5.9	5.0	2.4
	C	BPS	6.8	9.2	12.0	6.5	8.2	6.7	3.2	1.6
	E	0	9.1	7.3	15.8	6.4	8.4	5.0	5.3	2.6
Ponimin	A	CRIFC	9.2	13.1	11.7	6.9	9.3	4.4	6.7	2.2
	C	BPS	4.4	9.6	6.7	5.7	6.9	6.9	9.3	4.6
	E	0	10.4	13.8	11.1	8.6	11.1	5.9	7.6	0.4
Suwito	A	CRIFC	11.0	10.6	9.9	6.5	11.0	3.2	5.9	1.0
	C	BPS	11.8	11.7	11.0	8.3	12.6	4.4	3.8	3.5
	E	0	11.6	10.6	10.6	9.3	11.4	4.9	5.5	0.7
Average	**A**	**CRIFC**	**9.2**	**11.0**	**11.6**	**7.0**	**9.8**	**4.5**	**5.9**	**1.8**
	C	**BPS**	**9.3**	**10.4**	**11.5**	**7.4**	**10.4**	**5.6**	**3.5**	**2.5**
	E	**0**	**10.4**	**10.6**	**12.5**	**8.1**	**10.3**	**5.3**	**6.1**	**1.2**

(fire

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 72 months

Treatments	Girth in cm (%)
Rice with CRIFC dose	37.0 (100)
Rice with BPS dose	41.2 (111)
Rice without fertilizer	38.7 (105)
Local rice without fertilizer	34.5 (93)

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 66 months

Treatments	Girth in cm (%)
Rice with CRIFC dose	42.6 (100)
Rice with BPS dose	42.9 (101)
Rice without fertilizer	45.1 (106)

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 for light.

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.

RAS 3.2

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.

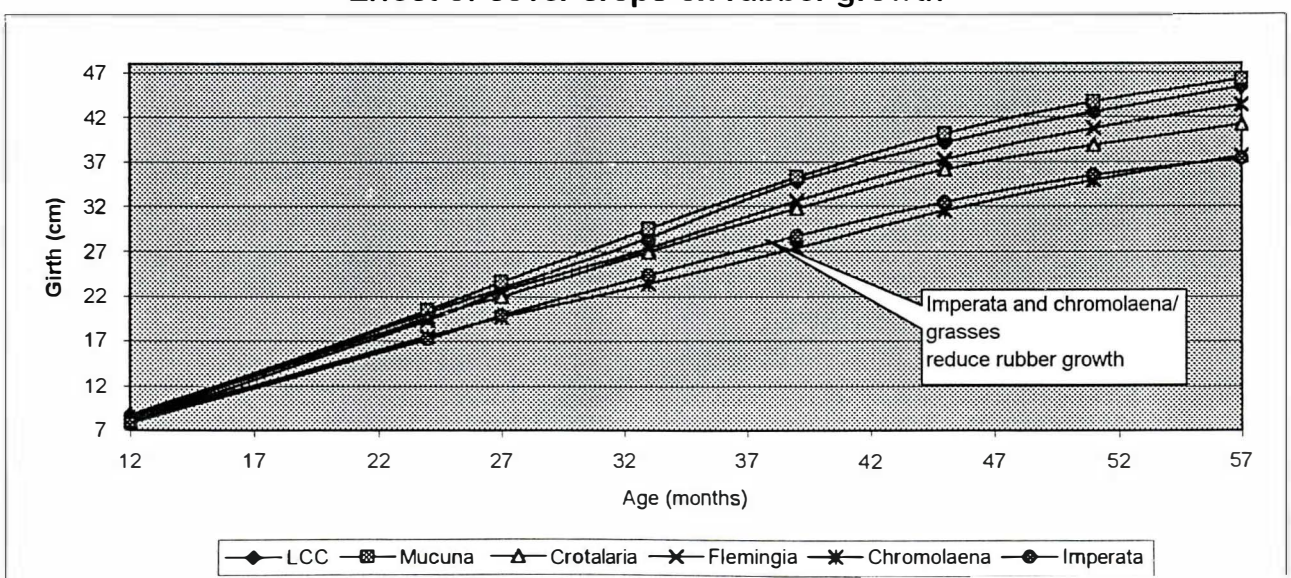
- Farmer's labor for each plot.
- Soil samples per replication on 0-10 and 10-20 cm.

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	Feb-00	Aug-00	Feb-01	Aug-01
Akut	A	LCC	9.6	20.4	24.1	30.0	37.1	41.5	44.7	47.3
	B	*Mucuna cochensinensis*	9.5	23.0	27.2	32.2	39.5	44.3	47.1	50.0
	C	*Crotalaria anagyroides*	10.1	22.8	26.8	32.6	37.7	41.5	43.7	46.0
	D	*Flemingia macrophylla*	9.1	20.4	23.1	28.7	33.8	38.0	40.5	43.0
	E	*Chromolaena odorata*	9.4	18.3	20.8	25.1	29.7	33.5	37.0	40.2
	F	*Imperata cylindrica*	10.1	21.7	24.7	29.8	34.8	37.7	41.7	42.6
Kimbon	A	LCC	8.1	19.9	22.0	27.8	34.4	38.8	42.6	45.8
	B	*Mucuna cochensinensis*	6.6	17.0	20.0	26.6	32.5	38.8	42.6	46.0
	C	*Crotalaria anagyroides*	5.8	13.3	15.4	19.1	22.8	28.0	30.2	33.8
	D	*Flemingia macrophylla*	6.9	14.7	17.6	21.7	26.5	31.9	34.3	37.9
	E	*Chromolaena odorata*	6.5	13.5	15.1	18.6	22.4	27.8	31.2	35.3
	F	*Imperata cylindrica*	4.9	10.1	11.8	16.7	19.9	24.5	26.1	28.0
Kolanus	A	LCC	8.5	19.8	23.0	29.2	35.2	40.2	44.2	46.4
	B	*Mucuna cochensinensis*	7.2	18.6	21.4	28.8	34.0	38.8	43.1	45.1
	C	*Crotalaria anagyroides*	9.0	19.5	22.1	27.6	32.9	38.3	41.9	43.9
	D	*Flemingia macrophylla*	6.1	17.7	22.9	27.9	33.6	39.1	43.7	46.6
	E	*Chromolaena odorata*	7.8	17.6	19.4	24.2	29.4	34.9	39.1	41.4
	F	*Imperata cylindrica*	8.3	17.9	20.9	26.7	32.6	38.1	42.4	44.6
Rasyid	A	LCC	8.4	19.8	23.0	28.5	35.3	39.9	43.2	45.9
	B	*Mucuna cochensinensis*	7.5	18.4	21.1	25.6	30.4	35.3	39.1	41.3
	C	*Crotalaria anagyroides*	7.0	16.7	19.1	21.5	25.8	28.3	30.9	32.0
	D	*Flemingia macrophylla*	7.6	18.7	22.0	25.9	31.1	35.6	39.7	41.3
	E	*Chromolaena odorata*	6.8	14.1	15.8	18.4	19.6	21.4	23.9	25.2
	F	*Imperata cylindrica*	4.8	11.8	14.4	16.7	18.4	20.5	22.4	24.4
Yohanes	A	LCC	8.9	20.6	22.6	26.8	31.8	35.4	38.0	41.3
	B	*Mucuna cochensinensis*	9.6	25.3	28.6	34.2	39.8	43.7	46.6	48.5
	C	*Crotalaria anagyroides*	10.4	25.9	26.7	34.2	39.6	44.5	47.5	50.0
	D	*Flemingia macrophylla*	10.1	25.0	27.4	32.6	38.1	41.9	45.5	47.6
	E	*Chromolaena odorata*	10.2	24.2	27.2	31.0	35.9	39.7	43.4	46.1
	F	*Imperata cylindrica*	10.7	24.6	27.6	31.9	37.9	41.4	44.9	47.2
Average	**A**	**LCC**	**8.7**	**20.1**	**23.0**	**28.5**	**34.7**	**39.2**	**42.5**	**45.3**
	B	***Mucuna cochensinensis***	**8.1**	**20.5**	**23.7**	**29.5**	**35.3**	**40.2**	**43.7**	**46.2**
	C	***Crotalaria anagyroides***	**8.5**	**19.6**	**22.0**	**27.0**	**31.7**	**36.1**	**38.8**	**41.1**
	D	***Flemingia macrophylla***	**8.0**	**19.3**	**22.6**	**27.4**	**32.6**	**37.3**	**40.7**	**43.3**
	E	***Chromolaena odorata***	**8.1**	**17.5**	**19.7**	**23.5**	**27.4**	**31.5**	**34.9**	**37.6**
	F	***Imperata cylindrica***	**7.8**	**17.2**	**19.9**	**24.4**	**28.7**	**32.4**	**35.5**	**37.4**

Effect of cover crops on rubber growth



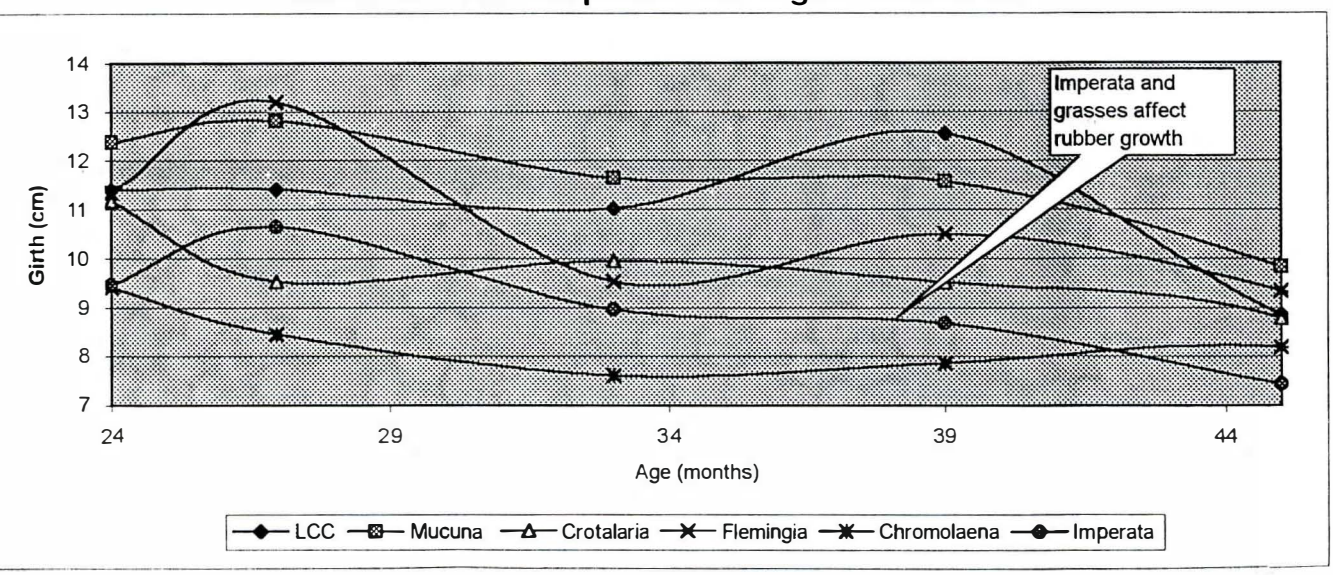
RAS 32 a - WEST KALIMANTAN

Effect of various cover crops on annual girth increment

lanting November 1996 Kopar 2

armer	Plot	Various cover crops	Girth (cm)						
			Nov-97	Nov-98	Feb-99	Aug-99	Feb-00	Aug-00	Feb-01	Aug-01
kut	A	LCC	10.8	14.8	11.8	14.1	8.9	6.3	5.3
	B	*Mucuna cochensinensis*	13.5	16.8	10.0	14.6	9.5	5.6	5.9
	C	*Crotalana anagyroides*	12.7	16.0	11.6	10.2	7.6	4.3	4.7
	D	*Flemingia macrophylla*	11.3	10.8	11.2	10.3	8.2	5.1	5.0
	E	*Chromolaena odorata*	8.9	10.0	8.6	9.3	7.6	6.8	6.4
	F	*Imperata cylindrica*	11.6	12.1	10.2	10.0	5.8	8.1	1.7
imbon	A	LCC	11.8	8.5	11.5	13.3	8.8	7.6	6.4
	B	*Mucuna cochensinensis*	10.4	12.0	13.2	11.8	12.6	7.6	6.8
	C	*Crotalaria anagyroides*	7.5	8.4	7.3	7.5	10.5	4.3	7.2
	D	*Flemingia macrophylla*	7.8	11.6	8.2	9.5	10.8	4.8	7.3
	E	*Chromolaena odorata*	7.0	6.2	7.1	7.6	10.9	6.7	8.2
	F	*Imperata cylindrica*	5.2	6.8	9.8	6.4	9.1	3.3	3.8
olanus	A	LCC	11.3	12.8	12.4	11.9	10.1	8.0	4.4
	B	*Mucuna cochensinensis*	11.4	11.2	14.8	10.5	9.5	8.6	3.9
	C	*Crotalaria anagyroides*	10.5	10.4	11.0	10.6	10.9	7.1	4.0
	D	*Flemingia macrophylla*	11.6	20.8	10.0	11.3	11.0	9.2	5.8
	E	*Chromolaena odorata*	9.8	7.2	9.6	10.4	11.0	8.4	4.6
	F	*Imperata cylindrica*	9.6	12.0	11.6	11.7	11.0	8.6	4.5
asyid	A	LCC	11.4	12.8	11.0	13.5	9.3	6.6	5.4
	B	*Mucuna cochensinensis*	10.9	10.8	9.0	9.7	9.8	7.5	4.5
	C	*Crotalaria anagyroides*	9.7	9.6	4.8	8.5	5.0	5.2	2.1
	D	*Flemingia macrophylla*	11.1	13.2	7.8	10.3	9.1	8.1	3.3
	E	*Chromolaena odorata*	7.3	6.8	5.2	2.3	3.6	5.1	2.6
	F	*Imperata cylindrica*	7.0	10.4	4.6	3.3	4.2	3.8	4.0
ohanes	A	LCC	11.7	8.1	8.3	9.9	7.2	5.3	6.5
	B	*Mucuna cochensinensis*	15.7	13.2	11.2	11.3	7.7	5.9	3.8
	C	*Crotalaria anagyroides*	15.5	3.2	15.0	10.8	9.9	6.0	5.0
	D	*Flemingia macrophylla*	14.9	9.6	10.4	11.0	7.5	7.2	4.2
	E	*Chromolaena odorata*	14.0	12.0	7.6	9.7	7.8	7.3	5.4
	F	*Imperata cylindrica*	13.9	12.0	8.6	12.0	7.0	6.9	4.8
Average	**A**	**LCC**	**11.4**	**11.4**	**11.0**	**12.5**	**8.9**	**6.8**	**5.6**
	B	***Mucuna cochensinensis***	**12.4**	**12.8**	**11.6**	**11.6**	**9.8**	**7.1**	**5.0**
	C	***Crotalaria anagyroides***	**11.2**	**9.5**	**9.9**	**9.5**	**8.8**	**5.4**	**4.6**
	D	***Flemingia macrophylla***	**11.3**	**13.2**	**9.5**	**10.5**	**9.3**	**6.9**	**5.1**
	E	***Chromolaena odorata***	**9.4**	**8.4**	**7.6**	**7.9**	**8.2**	**6.9**	**5.4**
	F	***Imperata cylindrica***	**9.5**	**10.6**	**9.0**	**8.7**	**7.4**	**6.1**	**3.8**

Effect of cover crops on annual girth increment



RAS 32 a - WEST KALIMANTAN
Rubber girth at 57 months
in cover crops plots

Farmer	LCC	*Mucuna*	*Crotalaria*	*Flemingia*	*Chromolaena*	*Imperata*
Akut	47.3	50.0	46.0	43.0	40.2	42.6
Kimbon	45.8	46.0	33.8	37.9	35.3	28.0
Kolanus	46.4	45.1	43.9	46.6	41.4	44.6
Rasyid	45.9	41.3	32.0	41.3	25.2	24.4
Yohanes	41.3	48.5	50.0	47.6	46.1	47.2
Average	45.3	46.2	41.1	43.3	37.6	37.4

Anova: Two-Factor Without Replication

SUMMARY	*Count*	*Sum*	*Average*	*Variance*
Akut	6	269.11	44.85	12.92
Kimbon	6	226.82	37.80	49.84
Kolanus	6	268.00	44.67	3.60
Rasyid	6	210.13	35.02	83.44
Yohanes	6	280.80	46.80	9.05
LCC	5	226.73	45.35	5.52
Mucuna	5	230.99	46.20	11.20
Crotalaria	5	205.68	41.14	62.11
Flemingia	5	216.47	43.29	15.48
Chromolaena	5	188.15	37.63	63.01
Imperata	5	186.84	37.37	108.38

lsd 5% = 6.16
lsd 1% = 8.40

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*	
Farmer	626.59	4	156.65	7.182	0.001	2.866	**
Cover crop	358.03	5	71.61	3.283	0.025	2.711	*
Error	436.22	20	21.81				
Total	1420.83	29					

Mucuna	46.20	a
LCC	45.35	a
Flemingia	43.29	a
Crotalaria	41.14	a
Imperata	37.37	ab
Chromolaena	37.63	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 57 months

Treatments	Girth in cm (%)
Rubber with LCC	45.4 (100) a
Rubber with *Mucuna cochensinensis*	46.2 (102) a
Rubber with *Crotalaria anagyroides*	41.1 (91) a
Rubber with *Flemingia macrophylla*	43.3 (95) a
Rubber with *Chromolaena odorata*	37.6 (83) b
Rubber with *Imperata cylindrica*	37.4 (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

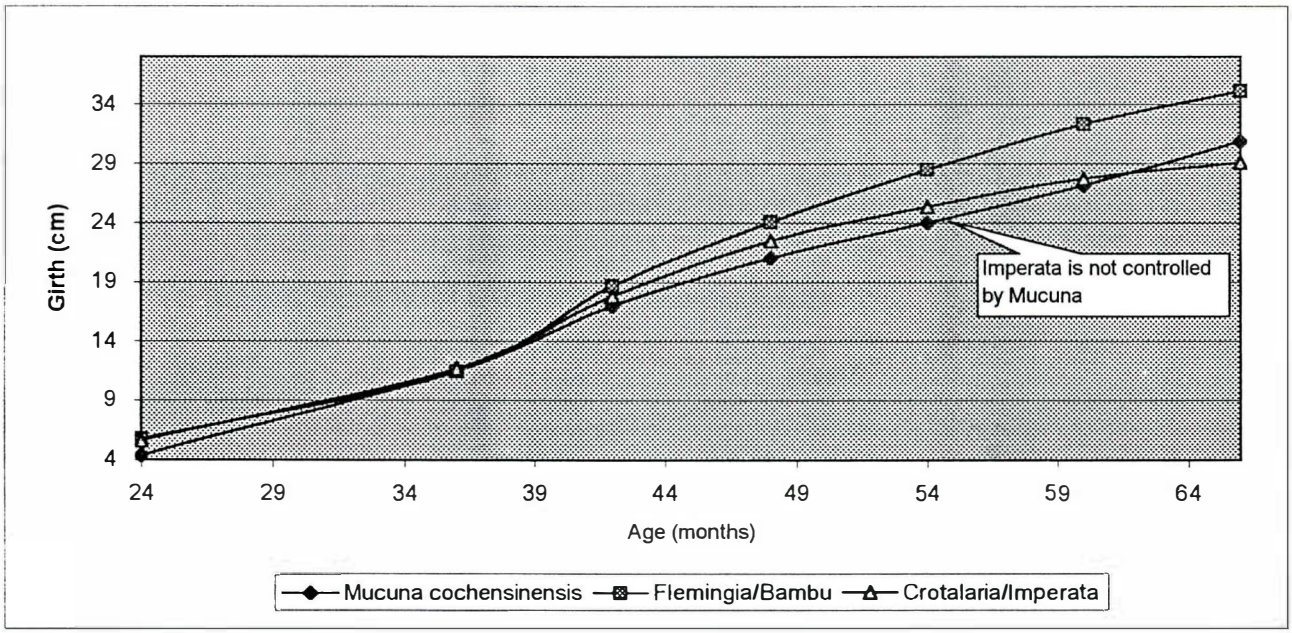
Farmer	Plot	Various cover crops	Girth (cm)								
			Feb-97	Feb-98	Aug-99	Feb-99	Aug-99	Feb-00	Aug-00	Feb-01	Aug-01
Abui	A	*Mucuna cochensinensi*	5.1	14.9	20.3	24.4	26.5	28.7	31.8	33.2	35.6
	B	*Flemingia/Bambu*	6.6	11.2	18.0	22.6	25.8	28.5	30.6	32.2	33.8
	C	*Crotalaria/Imperata*	5.6	11.7	17.8	22.5	25.3	27.7	29.1	31.3	33.4
Kai	A	*Mucuna cochensinensi*	3.7	8.1	13.7	17.7	21.5	25.5	29.9	31.3	33.3
	B	*Flemingia/Bambu*	4.8	11.7	19.3	25.5	31.1	36.2	39.6	43.5	45.2
	C	*Crotalaria/Imperata*	-	1.3	4.6	6.6	8.3	9.7	12.5	15.0	18.2

fire

(1) Supplies

Average	**A**	***Mucuna cochensinen***	**4.4**	**11.5**	**17.0**	**21.0**	**24.0**	**27.1**	**30.9**	**32.3**	**34.5**
	B	***Flemingia/Bambu***	**5.7**	**11.4**	**18.7**	**24.1**	**28.4**	**32.4**	**35.1**	**37.8**	**39.5**
	C	***Crotalaria/Imperata***	**5.6**	**11.7**	**17.8**	**22.5**	**25.3**	**27.7**	**29.1**	**31.3**	**33.4**

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

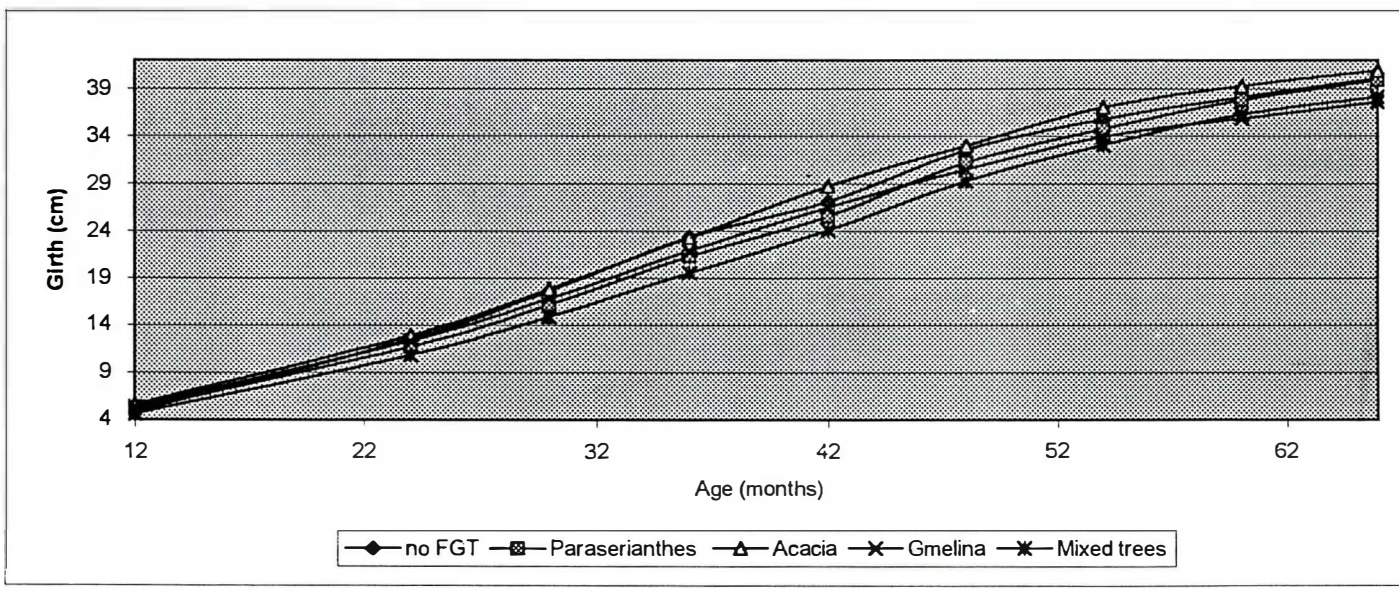
COVERCROPS
- Control of growth and ground cover.
- Farmer's labor for each plot.
- soil samples per replication on 0-10 and 10-20 cm.

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	Feb-01	Aug
Angkong	A	no FGT	4.6	9.4	14.9	20.1	23.7	28.9	31.8	34.2	36
	B	*Paraserianthes falcataria*	5.1	9.1	11.7	15.3	19.2	23.6	27.9	31.6	33
	C	*Acacia mangium*	5.8	12.9	19.5	25.7	29.6	35.2	39.0	40.2	42
	D	*Gmelina arborea*	6.4	14.9	21.8	28.1	31.0	35.1	37.9	40.1	42
	E	Mixed trees	4.9	10.8	15.3	20.3	24.1	28.7	32.6	36.6	38
Joni	A	no FGT	5.5	13.6	16.6	22.0	24.6	29.9	33.5	34.4	35
	B	*Paraserianthes falcataria*	5.4	11.3	16.2	22.0	25.4	32.2	35.5	37.3	39
	C	*Acacia mangium*	6.6	11.6	14.0	18.5	26.0	28.3	33.6	35.3	37
	D	*Gmelina arborea*	6.2	13.3	15.3	19.2	25.3	27.9	31.6	31.8	32
	E	Mixed trees	4.4	9.0	11.1	15.1	19.7	26.0	30.3	32.5	33
Noh	A	no FGT	4.5	14.6	21.4	27.8	33.0	38.7	42.1	45.8	48
	B	*Paraserianthes falcataria*	4.8	14.8	20.6	26.6	32.0	37.7	40.9	44.6	46
	C	*Acacia mangium*	4.5	14.4	19.9	25.8	30.6	35.6	38.5	42.4	43
	D	*Gmelina arborea*	3.5	8.7	13.3	18.4	23.3	28.5	32.3	35.7	38
	E	Mixed trees	4.6	12.6	18.3	23.2	28.4	33.1	36.4	39.9	42
Average	**A**	**no FGT**	**4.9**	**12.5**	**17.6**	**23.3**	**27.1**	**32.5**	**35.8**	**38.1**	**40**
	B	***Paraserianthes falcataria***	**5.1**	**11.7**	**16.2**	**21.3**	**25.5**	**31.2**	**34.8**	**37.8**	**39**
	C	***Acacia mangium***	**5.6**	**13.0**	**17.8**	**23.3**	**28.7**	**33.0**	**37.0**	**39.3**	**40**
	D	***Gmelina arborea***	**5.4**	**12.3**	**16.8**	**21.9**	**26.5**	**30.5**	**33.9**	**35.9**	**37**
	E	**Mixed trees**	**4.6**	**10.8**	**14.9**	**19.5**	**24.0**	**29.3**	**33.1**	**36.3**	**38**

Effect of FGT on rubber growth

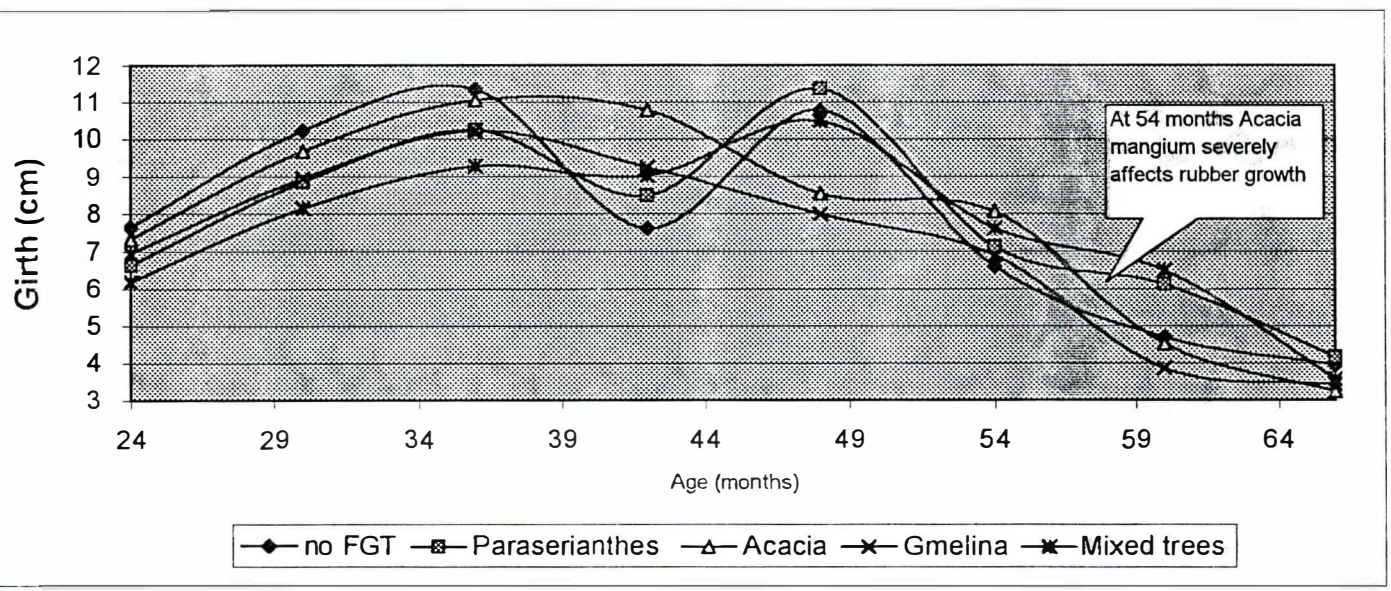


RAS 33 - WEST KALIMANTAN
Effect of associated fast growing trees (FGT) on annual rubber girth increment

nting February 1996 - Engkayu 2

mer	Plot	Associated FGT	Annual girth increment (cm)							
			Feb-97	Feb-98	Aug-98	Feb-99	Aug-99	Feb-00	Aug-00	Feb-01	Aug-01
gkong	A	no FGT		4.8	11.0	10.4	7.2	10.3	5.8	4.8	4.7
	B	*Paraserianthes falcataria*		4.0	5.2	7.1	7.8	9.0	8.5	7.3	4.1
	C	*Acacia mangium*		7.1	13.2	12.4	7.8	11.1	7.7	2.5	3.6
	D	*Gmelina arborea*		8.5	13.7	12.6	5.8	8.3	5.6	4.4	4.7
	E	Mixed trees		5.9	9.0	10.0	7.5	9.2	7.9	7.9	3.9
ni	A	no FGT		8.1	6.1	10.9	5.2	10.6	7.3	1.7	2.8
	B	*Paraserianthes falcataria*		5.9	9.8	11.6	6.8	13.7	6.5	3.7	4.4
	C	*Acacia mangium*		5.0	4.9	9.0	15.0	4.5	10.7	3.2	3.8
	D	*Gmelina arborea*		7.1	3.9	7.9	12.1	5.3	7.4	0.4	0.8
	E	Mixed trees		4.6	4.1	8.0	9.3	12.7	8.5	4.5	1.7
h	A	no FGT		10.1	13.6	12.8	10.4	11.5	6.7	7.5	4.3
	B	*Paraserianthes falcataria*		10.0	11.6	12.0	10.9	11.4	6.3	7.3	4.0
	C	*Acacia mangium*		9.9	11.0	11.8	9.6	10.0	5.8	7.9	2.3
	D	*Gmelina arborea*		5.2	9.2	10.1	9.8	10.4	7.7	6.7	4.8
	E	Mixed trees		8.0	11.3	9.8	10.3	9.5	6.5	7.1	5.2
erage	**A**	**no FGT**		**7.6**	**10.2**	**11.3**	**7.6**	**10.8**	**6.6**	**4.7**	**4.0**
	B	***Paraserianthes falcataria***		**6.6**	**8.8**	**10.2**	**8.5**	**11.4**	**7.1**	**6.1**	**4.2**
	C	***Acacia mangium***		**7.3**	**9.7**	**11.1**	**10.8**	**8.5**	**8.1**	**4.5**	**3.2**
	D	***Gmelina arborea***		**6.9**	**8.9**	**10.2**	**9.2**	**8.0**	**6.9**	**3.9**	**3.4**
	E	**Mixed trees**		**6.2**	**8.2**	**9.3**	**9.0**	**10.5**	**7.6**	**6.5**	**3.6**

Effect of FGT on annual girth increment



RAS 33 - WEST KALIMANTAN
Rubber girth at 66 months
in fast growing trees plots

	Different FGT with rubber				
Farmer	no FGT	*Paraser.*	*Acacia*	*Gmelina*	Mixed trees
Angkong	36.5	33.6	42.0	42.5	38.5
Joni	35.8	39.5	37.2	32.2	33.3
Noh	48.0	46.6	43.5	38.1	42.5
Average	40.1	39.9	40.9	37.6	38.1

Anova: Two-Factor Without Replication

SUMMARY	*Count*	*Sum*	*Average*	*Variance*
Angkong	5	193.15	38.63	13.98
Joni	5	177.99	35.60	8.71
Noh	5	218.70	43.74	14.89
no FGT	3	120.35	40.12	46.85
Paraser.	3	119.70	39.90	41.99
Acacia	3	122.70	40.90	11.13
Gmelina	3	112.75	37.58	26.75
Mixed trees	3	114.34	38.11	21.22

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*	
Farmer	169.37	2	84.686	5.355	0.033	4.459	*
Type of FGT	23.80	4	5.951	0.376	0.820	3.838	
Error	126.52	8	15.814				
Total	319.69	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 66 months

Treatments	Girth in cm (%)
Rubber alone	40.1 (100)
Rubber with *Paraserianthes falcataria*	39.9 (99)
Rubber with *Acacia mangium*	40.9 (102)
Rubber with *Gmelina arborea*	37.6 (94)
Rubber with Mixed FGT trees	38.1 (95)

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

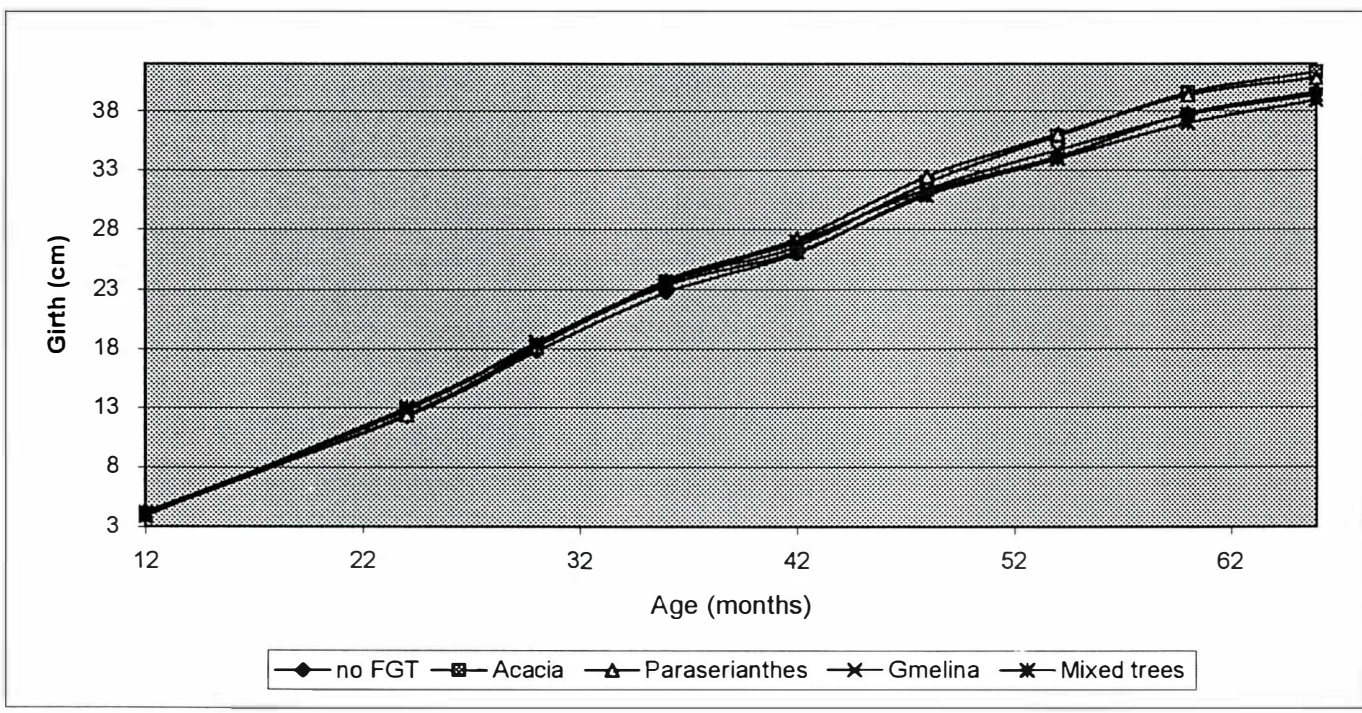
- Control of growth and ground cover.
- Farmer's labor for each plot.
- Soil samples per replication on 0-10 and 10-20 cm.

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	Feb-01	Aug-01
Margono	A	no FGT	3.2	9.8	15.0	19.5	22.0	27.3	28.4	31.2	33.1
	B	*Acacia mangium*	3.2	12.1	17.7	23.9	26.8	31.7	34.9	37.7	39.1
	C	*Paraserianthes falcatari*	3.2	9.0	14.1	19.9	23.4	29.0	31.9	34.9	36.6
	D	*Gmelina arborea*	3.4	10.4	15.6	20.2	23.1	26.4	28.2	29.8	31.3
	E	Mixed trees	3.2	11.6	16.4	20.6	22.7	26.6	28.4	30.4	32.6
Sarjono	A	no FGT	5.2	15.6	22.0	26.8	30.9	35.0	38.5	42.2	43.6
	B	*Acacia mangium*	3.9	13.4	19.6	24.7	28.1	33.9	37.9	42.2	43.8
	C	*Paraserianthes falcatari*	4.6	15.1	21.1	26.4	30.0	34.6	38.4	41.9	43.2
	D	*Gmelina arborea*	4.9	15.5	21.9	27.4	31.3	36.0	39.7	43.2	44.8
	E	Mixed trees	5.2	15.9	21.9	26.9	30.3	35.3	38.6	42.0	43.6
Sriadi	A	no FGT	4.4	11.4	16.3	21.8	25.0	31.0	35.6	40.0	42.2
	B	*Acacia mangium*	4.9	11.6	17.1	22.3	24.8	30.3	34.7	38.8	41.1
	C	*Paraserianthes falcatari*	4.3	13.0	19.2	25.0	28.2	33.8	37.7	41.4	42.7
	D	*Gmelina arborea*	4.2	12.6	18.1	23.1	26.3	31.9	36.2	40.1	42.0
	E	Mixed trees	3.4	11.6	16.8	22.4	25.3	30.7	34.9	38.7	40.7
Average	**A**	**no FGT**	**4.3**	**12.3**	**17.8**	**22.7**	**25.9**	**31.1**	**34.2**	**37.8**	**39.6**
	B	***Acacia mangium***	**4.0**	**12.4**	**18.1**	**23.6**	**26.6**	**31.9**	**35.8**	**39.6**	**41.3**
	C	***Paraserianthes falcat***	**4.0**	**12.3**	**18.1**	**23.8**	**27.2**	**32.5**	**36.0**	**39.4**	**40.8**
	D	***Gmelina arborea***	**4.2**	**12.8**	**18.5**	**23.6**	**26.9**	**31.4**	**34.7**	**37.7**	**39.4**
	E	**Mixed trees**	**3.9**	**13.0**	**18.4**	**23.3**	**26.1**	**30.8**	**33.9**	**37.0**	**38.9**

Effect of FGT on rubber growth

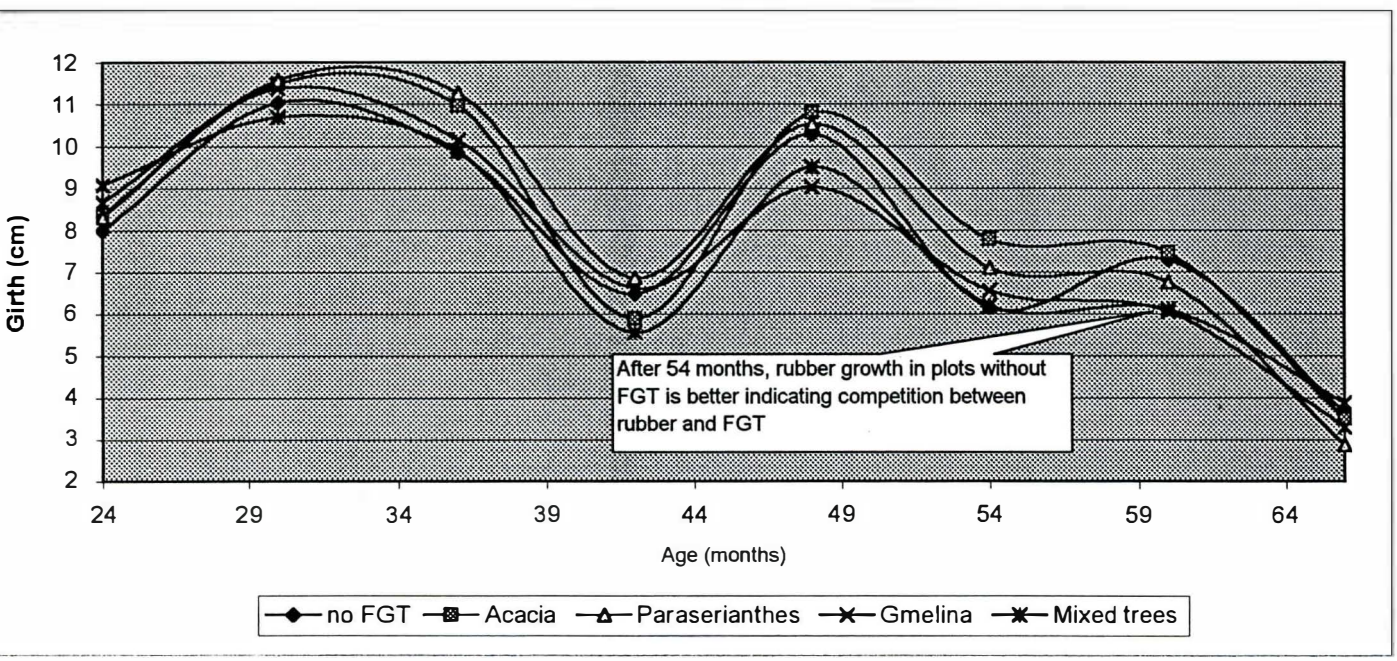


RAS 34 - WEST KALIMANTAN
Effect of associated fast growing trees (FGT) on annual rubber girth increment

anting February 1996 - Engkayu

mer	Plot	Associated FGT	Annual girth increment (cm)							
			Feb-97	Feb-98	Aug-98	Feb-99	Aug-99	Feb-00	Aug-00	Feb-01	Aug-01
rgono	A	no FGT	6.6	10.4	9.1	4.9	10.7	2.1	5.6	3.8
	B	*Acacia mangium*	8.9	11.0	12.4	5.8	9.8	6.6	5.5	2.8
	C	*Paraserianthes falcataria*	5.8	10.3	11.5	7.1	11.2	5.9	5.9	3.4
	D	*Gmelina arborea*	7.0	10.4	9.2	5.7	6.6	3.7	3.2	3.0
	E	Mixed trees	8.4	9.7	8.4	4.2	7.8	3.5	4.1	4.4
rjono	A	no FGT	10.4	12.8	9.6	8.1	8.2	7.0	7.5	2.8
	B	*Acacia mangium*	9.5	12.4	10.2	6.8	11.6	8.0	8.7	3.1
	C	*Paraserianthes falcataria*	10.5	12.0	10.7	7.1	9.2	7.7	7.0	2.6
	D	*Gmelina arborea*	10.6	12.8	11.1	7.7	9.3	7.5	7.1	3.2
	E	Mixed trees	10.7	12.0	10.0	6.7	10.0	6.7	6.7	3.3
adi	A	no FGT	7.0	9.9	10.8	6.5	11.9	9.3	8.8	4.3
	B	*Acacia mangium*	6.7	11.0	10.3	5.2	11.0	8.7	8.1	4.6
	C	*Paraserianthes falcataria*	8.7	12.4	11.6	6.4	11.3	7.8	7.4	2.6
	D	*Gmelina arborea*	8.4	11.0	10.2	6.4	11.1	8.5	7.9	3.7
	E	Mixed trees	8.2	10.4	11.3	5.7	10.7	8.4	7.6	4.0
erage	**A**	**no FGT**	**8.0**	**11.0**	**9.8**	**6.5**	**10.3**	**6.2**	**7.3**	**3.7**
	B	***Paraserianthes falcataria***	**8.4**	**11.5**	**11.0**	**5.9**	**10.8**	**7.8**	**7.5**	**3.5**
	C	***Acacia mangium***	**8.3**	**11.6**	**11.3**	**6.9**	**10.5**	**7.1**	**6.8**	**2.9**
	D	***Gmelina arborea***	**8.7**	**11.4**	**10.2**	**6.6**	**9.0**	**6.6**	**6.1**	**3.3**
	E	**Mixed trees**	**9.1**	**10.7**	**9.9**	**5.6**	**9.5**	**6.2**	**6.1**	**3.9**

Effect of FGT on annual girth increment



RAS 34 - WEST KALIMANTAN
Rubber girth at 66 months
in fast growing trees plots

Farmer	no FGT	*Paraser.*	*Acacia*	*Gmelina*	Mixed trees
Margono	33.1	39.1	36.6	31.3	32.6
Sarjono	43.6	43.8	43.2	44.8	43.6
Sriadi	42.2	41.1	42.7	42.0	40.7
Average	39.6	41.3	40.8	39.4	38.9

Anova: Two-Factor Without Replication

SUMMARY	*Count*	*Sum*	*Average*	*Variance*
Margono	5	172.61	34.52	10.32
Sarjono	5	219.05	43.81	0.37
Sriadi	5	208.59	41.72	0.69
no FGT	3	118.92	39.64	32.75
Paraser.	3	123.93	41.31	5.49
Acacia	3	122.48	40.83	13.77
Gmelina	3	118.09	39.36	50.93
Mixed trees	3	116.83	38.94	32.44

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*	
Farmer	237.39	2	118.70	28.45	0.000	4.46	**
FG trees	12.15	4	3.04	0.73	0.597	3.84	
Error	33.38	8	4.17				
Total	282.92	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 emitting 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 66 months

Treatments	Girth in cm (%)
Rubber alone	39.6 (100)
Rubber with *Paraserianthes falcataria*	41.3 (104)
Rubber with *Acacia mangium*	40.8 (103)
Rubber with *Gmelina arborea*	39.4 (99)
Rubber with Mixed FGT trees	38.9 (98)

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 during the first 3 years: conservation of soil moisture and building up of 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.