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Evaluation of Three Types of Rainguards

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Three types of rainguards were evaluated to compare their effectiveness over time. The economics of one type of rainguard and their possible role in minimising incidence of tree dryness through regularisation of tapping frequency and minimisation of recovery tapping were also evaluated.

The results showed that where there was monkey damage, Ebor eaves exhibited the least leakage among the rainguards. RRIMGUD and AA rainguards, both aluminium based rainguards suffered marked damage from monkeys. Where monkey damage was absent, AA rainguards were as effective as Ebor eaves. RRIMGUD was poorest.

In the trial evaluating the economics of using AA rainguards, rainguard areas suffered a loss of $95.35 per ha over ten months as a result of premature loss of protection from rain due to monkey damage to the rainguards. Tappers were also unwilling to turn up for work in rainguard areas on days where the balance of the estate which was not fitted with rainguards could not be tapped due to rain interference.

Although the above trial showed AA rainguards to be uneconomic in that situation, longer periods of protection against rain interference exceeding one year afforded by Ebor eaves and AA rainguards in some other situations and the ability to persuade tappers to turn out for work by the management may well reverse the position. Observations elsewhere have indicated other rainguards to be economically beneficial.

Tasks where recovery tapping was undertaken and which had 10 per cent more tappings mainly carried out on a d/1 frequency showed higher tree dryness than non-recovery tapping tasks. This finding however appears unrelated to the role of rainguards in minimising tree dryness in the above exercise.

Rain interference is a serious hazard in rubber estates, resulting in crop loss due to nil rapping, late tapping or washout.

Average crop loss due to rain interference has been estimated to be about 360 kg per ha per yr for normal estates (Gan, 1988) and about 30 per cent of annual yield for east coast estates of Peninsular Malaysia (Dahlan & Yahaya, 1979).

Rain interference on rubber estates can be minimised by use of rainguards.

Rainguards of various forms and shapes and using various materials to reduce rain interference have been widely evaluated (Southern, 1969; Rubber Research Institute of Ceylon, 1960). However, none were successful due mainly to the lack of an effective sealant which could prevent leakage and also allowed for the expansion of

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tree girth and were abandoned shortly.

Interest in rainguards resurfaced in 1988 within the Group estates following an upsurge in rubber prices which breached the $4.00 per kg mark for RSS1 and $8.00 per kg for latex concentrate. However, prices have dropped rather sharply of late.

EVALUATION OF RAINGUARDS

Two types of rainguards with improved sealants came into the market *viz;*

a) RRIMGUD, consisting of a ready to use crenulated aluminium foil sealed with a solid rubber polymer, marketed by Rubber Research Institute of Malaysia (RRIM).

b) Ebor eave, a hooded cap made of bituminous material and mounted with both an adhesive and sealant and produced by Sime Darby.

An experimental rainguard code-named AA rainguard and using a simple laminated aluminium foil and liquid sealant was also produced for evaluation.

The above rainguards were evaluated with the following objectives:–

i) to compare their effectiveness over time

ii) to evaluate the economics of rainguards

iii) to assess the possible role of rainguards in minimising dryness incidence through regularisation of tapping frequency and minimisation of recovery tapping..

i) *Trials to compare the effectiveness of the various rainguards*

Three trials were laid down in early 1989 in the following estates:–

a) Estate A in Bangi, Selangor on clone PB28/59 planted in 1976 and recently opened on panel BO2. Rainguards were mounted on virgin bark about 15 cm above the tapping cut.

b) Estate B in Trong, Perak on clone GT1 planted in 1976 and recently opened on panel BO2. Rainguards were mounted on virgin bark about 10 cm above the tapping cut.

c) Estate C in Tanjong Malim, Perak on clone PB260 planted in 1981 and already tapped for about two and a half years on panel BO1. Rainguards were mounted about 15 cm above the tapping cut on renewed bark.

Treatments consisted of fixing 150 units each of the three types of rainguards and were replicated three times.

After installation, the rainguards were tested for leakages with the use of a knapsack pump. All leakages were sealed prior to commencement of recording. In the case of RRIMGUD which leaked, pressure was reapplied to the point of attachment with the trunk to conceal all leakage points.

Measurements

Measurements consisted of recording leakages in the trial area once a month whenever possible after heavy rain when the rest of the estate could not be tapped due to rain interference. Recording of leaks using a knapsack pump to simulate rain was also carried out periodically.

One year after installation, a census of the number of damaged rainguards was carried out. Damaged rainguards denote rainguards which have been torn, detached from the trunk or completely inverted/collapsed from the point of attachment.

ii) *Trial on economics of AA rainguards and minimisation of dryness incidence*

This trial was laid down in Estate C where a large section of the estate was fitted with AA rainguards. Total commercial hectarage covered by the rainguards amounted to 177 ha or 24.0 per cent of the tapped hectares in the estate.

The treatments were:–

- Rainguard without recovery tapping
- Rainguard with recovery tapping
- Control without recovery tapping
- Control with recovery tapping

The treatments were replicated three times. Each treatment covered a full tapping task of ± 1.5 ha. Thus the trial area encompassed 18 ha of which 9 ha were mounted with rainguards.

Measurements

Yield. Yield recording was carried out on every tapping day by the estate in the form of latex (DRC) and cup-lump (54% dry weight).

A census of damaged rainguards was carried out one year after installation.

As rainguards suffered considerable damage in three out of the four trials, all trials were terminated after one year.

RESULTS

i) *Comparison of various rainguards*

a) *Estate A – 1976, PB28/59*

The results of leakage over time are presented in *Table 1.*

Pretreatment leakage. Leakages were highest for RRIMGUD at 7.8 per cent and lowest for Ebor eaves at 4.5 per cent recorded immediately after installation of rainguards.

Post treatment leakage. After repair of leakages, AA rainguards showed marginally lower leakage than Ebor eaves for the first six months but suffered slightly higher incidence thereafter. RRIMGUD continued to show the highest percentage leakage among the three rainguards throughout the period of evaluation.

At the end of one year, more than one third of the RRIM rainguards leaked. Ebor eaves had the least leakage at about 15 per cent while AA rainguard was marginally behind at 17.0 per cent *(Table 2).*

About 50 per cent of the AA rainguards and Ebor rainguards which leaked also suffered damage to the rainguard. About one third of the leaking RRIMGUD were damaged.

Precipitation from January to December 1989 was 1 775 mm recorded over 107 days.

b) *Estate B – 1976, GT1*

The results of leakage are shown in *Table 3.*

TABLE 1
LEAKAGE (%) OVER TIME IN RAINGUARDS TRIAL – ESTATE A, BANGI

Treatment	Pretreatment		Treatment	Time after treatment					
				3 months		6 months		9 months	
	Rainfall (mm)	Leakage (%)		Rainfall (mm)	Leakage (%)	Rainfall (mm)	Leakage (%)	Rainfall (mm)	Leakage (%)
AA Rainguards	Knapsack	6.1	FEBRUARY	35	3.8	30	6.5	Knapsack	10.6
RRIMGUD	Knapsack	7.8		35	12.4	30	18.8	Knapsack	24.4
Ebor eaves	Knapsack	4.5		35	5.0	30	6.8	Knapsack	7.7
			SE ±		3.2		3.9		4.6
			LSD 5%		12.7		15.6		18.1

Total rainfall (Jan. – Dec. 1989) – 1775 mm
Number of raindays (Jan. – Dec. 1989) – 107

TABLE 2
PERCENTAGE LEAKAGE AND DAMAGED RAINGUARDS – ONE YEAR AFTER INSTALLATION – ESTATE A

Treatment		Leakage (%)	Damaged rainguards (%)
AA Rainguards		16.9	7.4
RRIMGUD		36.5	13.1
Ebor eaves		14.8	7.3
	SE ±	6.0	
	LSD 5%	23.9	

Note: All damaged rainguards also leaked

Pretreatment leakage. RRIMGUD suffered the highest incidence of leakage at 14.1 per cent due mainly to monkey damage. Initial leakages were very low in AA rainguards and Ebor eaves at about 1.0 per cent for both types of rainguards.

All damaged RRIMGUD were removed and replaced with fresh materials.

Post-treatment leakage. RRIMGUD showed the highest incidence of leakage at 34.0 per cent, three months after 'installation' and increased to 54 per cent, three months later. The leakage percentage in AA rainguards and Ebor eaves were generally similar upto six months after installation when they were around 14 per cent. At nine months after installation the leakage percentage of AA rainguards increased to about twice that of Ebor eaves due mainly to monkey damage.

At the end of one year, RRIMGUD suffered 67 per cent leakage of which half were damaged, AA rainguards, 37 per cent and Ebor eaves, 21.1 per cent *(Table 4)*.

Precipitation from January to December 1989 was 3 050 mm recorded over 193 days.

c) *Estate C – 1981 PB260*

The results of this trial are given in *Tables 5* and *6*.

Pretreatment leakage. Considerable monkey damage to the AA rainguards and RRIMGUD was encountered soon after installation. Ebor eaves were however not damaged. The damaged rainguards were immediately replaced with fresh materials.

TABLE 3
LEAKAGE (%) OVER TIME IN RAINGUARDS TRIAL – ESTATE B, TRONG

Treatment	*Pretreatment*		*Treatment*	*Time after treatment*					
				3 months		*6 months*		*9 months*	
	Rainfall (mm)	*Leakage (%)*		*Rainfall (mm)*	*Leakage (%)*	*Rainfall (mm)*	*Leakage (%)*	*Rainfall (mm)*	*Leakage (%)*
AA Rainguards	Knapsack	1.4	F	19	9.6	13	14.2	Knapsack	27.7*
RRIMGUD	Knapsack	14.1*	E	19	34.0	13	54.0	Knapsack	54.0
Ebor eaves	Knapsack	1.2	B	19	11.2	13	13.9	Knapsack	14.6
			R						
			U						
			A						
			R						
			Y						
			SE ±		8.4		4.1		4.7
			LSD 5%		33.2		16.2		18.7

Total rainfall (Jan. – Dec. 1989) – 3 050 mm
Number of raindays (Jan. – Dec. 1989) – 193
* Mostly as a result of monkey damage

TABLE 4
PERCENTAGE LEAKAGE AND DAMAGED RAINGUARDS – ONE YEAR AFTER INSTALLATION -- ESTATE B

Treatment		*Leakage (%)*	*Damaged rainguards (%)*
AA Rainguards		37.0	17.5
RRIMGUD		67.0	34.6
Ebor eaves		21.1	3.1
	SE ±	4.2	
	LSD 5%	16.5	

Note: All damaged rainguards also leaked

Post-treatment leakage. Both RRIMGUD and AA rainguards showed very high leakages at around 50 per cent, three months after installation. Although lower, the leakage percentage of Ebor eaves at 30 per cent may still be considered high. Leaks continued to develop and at nine months after installation, the leakage percentage of RRIMGUD and AA rainguards ranged from 60–70 per cent. Ebor eaves continued to show the lowest leakage of 37.0 per cent.

One year after installation RRIMGUD showed 78 per cent leakage, AA rainguards, 72 per cent and Ebor eaves, 62 per cent. Most of the leakages in AA rainguards and RRIMGUD were due to damage by monkeys to the rainguards.

Precipitation from January to December 1989 was 3 077 mm recorded over 142 days.

ECONOMICS OF RAINGUARDS

i) *Tapping status – March to December 1989*

The tapping status from March to December 1989 is shown in *Table 7.*

TABLE 5
LEAKAGE (%) OVER TIME IN RAINGUARDS TRIAL – ESTATE C, TANJONG MALIM

Treatment	*Pretreatment*		*Treatment*	*Time after treatment*					
				3 months		*6 months*		*9 months*	
	Rainfall (mm)	*Leakage (%)*		*Rainfall (mm)*	*Leakage (%)*	*Rainfall (mm)*	*Leakage (%)*	*Rainfall (mm)*	*Leakage (%)*
AA Rainguards	Knapsack	*58.3	Feb./Mar.	4.16	45.6	38.16	58.8	33.07	59.6
RRIMGUD	Knapsack	*56.8	Feb./Mar.		55.3		61.3		67.0
Ebor eaves	Knapsack	0	Feb./Mar.		29.0		31.3		37.0
			SE ±		6.3		6.0		5.7
			LSD 5%		24.9		23.8		22.7

Total rainfall (Jan. – Dec. 1989) – 3 077 mm
Number of raindays (Jan. – Dec. 1989) – 142

* Damaged by monkeys

TABLE 6
PERCENTAGE LEAKAGE AND DAMAGED RAINGUARDS – ONE YEAR AFTER INSTALLATION – ESTATE C

Treatment		*Leakage (%)*	*Damaged rainguards (%)*
AA Rainguards		72	60
RRIMGUD		78	74
Ebor eaves		62	19
	SE ±	9.7	
	LSD 5%	38.1	

Note: All damaged rainguards also leaked

Total precipitation for the period amounted to 2 694 mm and the number of raindays recorded were 117 days. However, only eleven days were affected by rain *viz.* seven days or 6 per cent of total raindays when tapping was not possible due to 'wet' panels and four days or 3.5 per cent of total raindays when 'wash-out' occurred.

Except for the difference in the number of recovery tapping days to make up for days lost to public holidays, wintering effect, rain *etc.* when normal tapping was not carried out, the tapping status of all treatments (3 tasks each) were the same *viz*:–

- 272 normal tapping days
- twenty-five non-tapping days due to wintering rest, public holidays, factory shut-down
- seven non-tapping days due to rain interference and
- four 'wash-out' days.

No late tapping was carried out in all the treatments during the period as tappers were unwilling to work after 9.30 a.m. Tappers were also unwilling/unable to tap in the rainguard areas on the seven raindays because the balance of the estate was not in tapping due to wet panels.

The total possible tapping days for the period reviewed was 306 days.

Overall the out-turn percentage amounted to 89.5 per cent for treatments without recovery tapping and 100 per cent for treatments where recovery tapping was carried out.

ii) *Effect of rainguards on yield*

Table 8 gives the mean yield (kg/ha) obtained for the period (March–Dec. '89) for the rainguard and control areas.

Mean yield of the rainguard area was only marginally higher than the non-marginal area by 2 per cent over the ten month period.

However, when grouped into periods of approximately three months, the

TABLE 7
RAINGUARDS TRIAL, ESTATE C, TANJONG MALIM
TAPPING STATUS – MARCH TO DECEMBER 1989

Treatment	Total rain-fall	No. of rain-days	Normal tapping	Rain Interference (no. of days)			No. tapping (days)			Recovery tapping	Total days tapped	Total possible tapping days	% Out-turn
				Nil tapping	Late tapping	Wash-out	Wintering	Public holiday	Factory repair				
	2694	117											
AA Rainguards no recovery tapping			272	7	0	4	11	8	6	0	276	306	89.5
AA Rainguards, with recovery tapping			272	7	0	4	11	8	6	32	306	306	100.0
Control, no recovery tapping			272	7	0	4	11	8	6	0	276	306	89.5
Control, with recovery tapping			272	7	0	4	11	8	6	32	306	306	100.0

TABLE 8
MEAN YIELD (KG/HA) IN RAINGUARD AND CONTROL AREAS
MARCH – DECEMBER 1989

Period	Mean no. of tappings	Rain interference (days) Nil tapping	Wash-out	Rainguard	Mean no. of tappings	Control
March – May	26	2	2	305 (117%)	26	260 (100%)
June – August	28	1	1	523 (96%)	28	542 (100%)
September – December	38	4	1	835 (102%)	38	818 (100%)
	92			1663 (102%)	92	1620 (100%)
% damaged rainguards after 1 year				63.8%		

yield for the first period was 17 per cent higher in the rainguard than non-rainguard area while the remaining two periods showed generally similar yields between the two treatments.

One year after installation, damage to the rainguards, due mainly to monkeys was about 63 per cent for both the rainguards treatments with and without recovery tapping.

iii) *Effect of rainguards on yield on wash out days*

Mean yield obtained on wash-out days is shown in *Table 9*.

Mean yield per tapping on wash-out days was marginally higher in the rainguard area than non-rainguard area. However both were markedly lower than the yield obtained from tapping on a normal day.

Economics – Profit/loss statement

The economics of using rainguards at the current price of $2.50 per kg SMRCV is shown in *Table 10*.

A net loss of $95.35 per ha has resulted from the use of rainguards over the ten month period.

Effect of rainguards and recovery tapping on dryness incidence

The relationship between dryness incidence and recovery tapping obtained in the various treatments is shown in *Table 11*.

Recovery tapping resulted in twice as many dry trees as no recovery tapping. Recovery tapping was mainly carried out on d/1 frequency in the recovery tasks. However it should be noted that the treatments with recovery tapping also had about 10 per cent more tappings than treatments without recovery tapping which could have also contributed to the higher dryness.

DISCUSSION

Comparison of rainguards

In the comparison of various rainguards, Ebor eaves exhibited the least leakage in all three sites, followed by AA rainguards. RRIMGUD were poorest.

Leakages differed in magnitude at the various sites. In Estate A, leakage ranged from 14.8 to 36.5 per cent, in Estate B, 21.1 to 67.0 per cent and in Estate C, 62 to 78 per cent, one year after installation. The higher percentage of leaks in the latter two estates were mainly due to damage by monkeys particularly on RRIMGUD and AA rainguards. The shiny reflective surfaces of these aluminium based rainguards attracted hordes of monkeys to move up and down the trunk, damaging the rainguards in the process. Monkey damage to Ebor eaves was minor to negligible. The higher rainfall in these

TABLE 9
MEAN YIELD (KG/TAPPER) OBTAINED ON NORMAL TAPPING AND WASH-OUT DAYS

	Rainguards		*Control*	
Month	*Normal tapping*	*Wash-out*	*Normal tapping*	*Wash-out*
April	14.5	4.6	13.3	4.3
May	24.4	11.8	18.7	7.2
July	29.1	5.7	28.5	8.4
October	29.5	3.1	31.0	3.1
Mean	24.3 (426%)	6.3 (110%)	22.8 (400%)	5.7 (100%)

TABLE 10
ECONOMICS OF RAINGUARDS AT CURRENT PRICE OF SMR CV = $2.50/KG

Gross revenue ($/ha)	*Rainguards*		*Control*	
	No. 1	*scrap*	*No. 1*	*scrap*
Yield (kg/ha)	1290	373	1215	405
Gross revenue at $2.50/kg SMR CV	3225		3037	
Gross revenue at 2.25/kg SMR 10		839		911
Gross ref. SMR CV + SMR 10	4064		3948	
Expenditure ($/ha)				
Tapping cost ($220–240/kg price zone RSS 1)	1043		1028	
Manufact. 30¢/kg	498.00		486.00	
Duty 0.3¢/kg	4.98		4.86	
Research cess 3.85 ¢/kg	64.02		62.37	
Internal and external transp. 6¢/kg	99.78		92.20	
Cost of rainguards – 50¢/piece (40¢/mat. + 10¢/labour) Assuming 350 trees/ha	175.00		0	
Net revenue ($/ha)				
Gross revenue – Expenditure	2179.22		2274.57	
Profit/(Loss) $/ha	(95.35)			

TABLE 11
RELATIONSHIP BETWEEN DRYNESS INCIDENCE AND RECOVERY TAPPING (MARCH – DECEMBER '89)

Treatment	*No. re-covery*	*Re-covery*
Mean no. of tappings	92	102
Mean yield kg/ha	1642	1860
Mean no. of dry trees/task	10	20
Mean no. of days with recovery tapping on d/1 frequency	0	8½
Mean no. of days with recovery tapping on d/2 frequency	0	1½

two estates at over 3 000 mm in 1989 compared to only 1 775 mm in Estate A probably also contributed to the higher percentage of leaks.

In general, where there was monkey damage, Ebor eaves performed better than the other two rainguards as they were not tampered by the creatures. In the absence of monkey damage, AA rainguards were generally as effective as Ebor eaves, showing a leakage of 17 per cent compared to 15 per cent for Ebor eaves in the trial in Estate A. RRIMGUD performed poorest in both situations.

ECONOMICS OF AA RAINGUARDS

a) *Effect of rainguards on tapping status and yield*

Rain interference resulting in nil tapping and wash-out on seven days or 6 per cent of total raindays and on four days or 3.5 per cent respectively, was markedly lower than the corresponding 19 and 9 per cent obtained by Gan (1988). However, the estate reported an unusually higher proportion of afternoon and pre-midnight rains than previous years.

Although rainguards were installed over 24.0 per cent of the tapped hectare in the estate, tappers refused to turn up for either normal or late tapping in the areas mounted with rainguards on the seven raindays, in unison with the balance of the estate where tapping could not be carried out. This was unfortunate as any benefit which might have accrued from installation of the rainguards could not be realised.

Overall, yield in the rainguard area was only 2.0 per cent higher than the control over the ten-month period. Much of this difference was derived in the first three months where the yield was 17 per cent higher than the control. This extra yield was obtained without any extra tappings, indicating rainguards were effective in achieving a higher yield than the control during this period.

In this estate, tappers are reluctant to tap their tasks after 9.30 a.m. and the management has to decide before then whether to send the tappers out to their tasks even when panels are not completely dry as a result of rain falling earlier. Thirty-six raindays were recorded in the first three months of yield recording. It appears likely that during this period, the rainguards gave some protection to the tapping cuts, enabling them to dry out much earlier than the control trees on the raindays when partial rain interference was experienced. This probably resulted in lower spillage of latex on the tapping cuts and consequently higher yields in the rainguard than control areas. During this period 12 per cent more scrap than control was also obtained in the rainguard areas suggesting that the effectiveness of the rainguards were also extended to protection of loss of cup-lumps from post-tapping rains.

For the next seven months, the yield difference between the rainguard and control area was only 2 kg per ha indicating that the rainguards were completely ineffective three months after installation.

Rainguards marginally reduced crop loss on wash-out days by about 10 per cent over the control. However in view of the markedly low yields obtained on wash-out days when compared to normal tapping days, rainguards appeared to be of little consequence on wash-out days.

b) *Profit/loss statement*

Rainguard areas suffered a loss of $95.35 per ha over the period reviewed due mainly to the early loss of protection from rain caused by monkey damage in Estate C. It would appear that even if tappers had been willing to tap the rainguard areas on the seven days 'apparently' lost to rain, any yield advantage gained would have been minimal as five out of the seven occurred after May when rainguards had been rendered ineffective from monkey damage *(Table 8)*.

Correlation of performance of AA rainguards in Estate C and prediction of effectiveness of the various rainguards

One year after installation, AA rainguards in Estate C showed about 60 per cent damage in both the trials. In view of the similarity in performance of the rainguards in the two trials, it may be assumed that the loss of effectiveness of the rainguards at around the third month in the trial on economics of rainguards would correlate with about 45 per cent leakage recorded for AA rainguards at around the same time.

If the cut-off point for effective protection by rainguards is around 45 per cent leakage of rainguards, the period of effectiveness of the various rainguards at the three sites may be assessed to be:–

a) about one year for RRIMGUD and exceeding one year for Ebor eaves and AA rainguards in Estate A,
b) slightly more than three months for RRIMGUD, about one year for AA rainguards and exceeding one year for Ebor eaves in Estate B,
c) less than three months for RRIMGUD, about three months for AA rainguards and slightly more than nine months for Ebor eaves in Estate C.

Relationship between dryness incidence and recovery tapping

The 10 per cent higher number of tappings coupled with the recovery of 'lost tasks' undertaken mainly on a d/1 frequency may be adduced to have caused the higher dryness incidence in the tasks with recovery tapping.

This relationship however should not be attributed to the role of rainguards with respect to tree dryness in the above exercise, as the recovery tapping also included recovery of days 'lost' to wintering rest, public holidays and closure of factory for repairs, all of which are independent of the function of rainguards.

OVERVIEW

Although the trial in Estate C showed that use of AA rainguards was uneconomic in that situation, Ebor eaves and AA rainguards have been projected to give effective protection against rain interference exceeding one year in Estate A, and also in Estate B for Ebor eaves. If it can also be ensured that the total area fitted with rainguards is sufficiently large to induce tappers to turn up for work on 'wet days' so that the full benefit of rainguards can be reaped, the economics of AA rainguards could well be reversed. Ebor eaves and RRIMGUD have been reported to be economically viable elsewhere (Periyasamy, Said, Chew, Tiong & Wood, 1989; Ismail, Mohd Akbar & Ahmad Zarin, 1989).

The scale of fixing rainguards whereby sufficient tappers could be persuaded to turn up for work appears difficult to determine, and is likely to vary from place to place.

As it is unlikely that the whole estate can be fitted with rainguards especially where two cut systems are practised, the role of management in persuading tappers to turn out for work on 'wet days' would be vital.

The results have shown that Ebor eaves would be most suitable for areas where risk of damage by monkeys exists.

In the absence of monkey damage, both Ebor eaves and AA rainguards were equally effective, out performing RRIMGUD which showed considerably more leaks at the end of one year. AA rainguards are however easier to install as reflected in their lower cost of fixing of about 10¢ per unit compared to 30¢ for Ebor eaves. Leaks are also easily patched up by brushing over with sealant. As the role of rainguards appears mainly to divert the small stream of seepage *(Table 12)* flowing down the trunk from protracted wetting of the tapping cut after rain has stopped, recent observations indicate much scope for reduction in cost of AA rainguards by about 30–40 per cent by reducing the size of rainguards and amount of sealant used. This would continue to be monitored *(Table 13)*.

With the new MAPA/NUPW (1990), in force where estates have to offer a minimum of twenty-four working days to workers, rainguards where appropriately implemented, would enhance productivity in estates.

TABLE 12
MEAN PERCENTAGE OF STEM FLOW (SF)

Mean rainfall	*SF*	*TF*	*TT*	*I**
16.8	2	83	85	15

*Forms reservoir for continuous seepage down tree trank after rain has stopped
Through flow (TF), Total through flow (TT) and Interception (I)
After RRIM (1971)

TABLE 13
EVALUATION OF VARIOUS SIZE OF AA RAINGUARDS-ESTATE A – 3 MONTHS

Width of rainguards (cm)	*No. of units*	*No. of leakages*
2½	10	1
3	10	0
3½	10	1
4½ (control)	10	1

CONCLUSION

The salient features highlighted in the trials are.—

- Ebor eaves exhibited the least leakage in the sites where there was monkey damage. Both RRIMGUD and AA rainguards suffered considerable damage from monkeys while Ebor eaves were mainly unscathed.

  Where monkey damage was absent, AA rainguards were as effective as Ebor eaves. RRIMGUD was poorest.

- Tasks installed with AA rainguards suffered a loss of $95.35 ha over ten months due to early damage of the rainguards by monkeys. Tappers were also unwilling to turn up for work in rainguard areas on 'wet days'.

  However longer protection against rain interference exceeding one year afforded by Ebor eaves (Periyasamy, 1989) and AA rainguards in some other situations such as in Estate A and the ability to persuade tappers to turn out on 'wet days' by the management could well reverse the uneconomic position.

- Tasks where recovery tapping was carried out, amounting to 10 per cent more tappings which were also undertaken mainly on a d/1 frequency showed higher tree dryness than non-recovery tasks. This finding however is not attributed to the role of rainguard in minimising tree dryness.

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REFERENCES

ANON (1971). Where does all the rain go? *Plt. Bull.* 115; 1971.

DAHLAN K. & YAHAYA, H. (1979). Exploitation systems for east coast rubber – Prelim results. *Proc. Plrs. Conf.* K.L. 1979.

GAN L.T. (1988). Amelioration of rain interference with rubber tapping by use of 'Ebor eaves'. *The Planter,* **64** (742), 15-26.

ISMAIL HASHIM, MOHD AKBAR MD. SAID & AHMAD ZARIN (1989). Towards higher productivity – Development of RRIMGUD and RRIMCAP. Abstract of Papers. Rubber Growers Conference, Malacca 1989. Pg. 65.

PERIYASAMY K., SAID ISMAIL, CHEW OE KHENG, JAN LIAN TIONG & WOOD B.J. (1989). Benefits of Ebor Eave Rainguards on some representative estates in Peninsular Malaysia. Abstract of Papers. Rubber Growers Conference, Malacca 1989. Pg. 64–65.

RUBBER RESEARCH INSTITUTE OF CEYLON (1960). *Planting topics, tapping for increased yields with the use of rainguards.* Rubb. Res. Inst. Ceylon, 36 (3 & 4), 63.

SOUTHERN, W.A. (1969). Latex collection in disposable plastic bags and the use of expanded plastic rainguards. *Pltrs. Bull.* Rubber Res. Inst. Malaysia No. 104, 156.

An Analysis of Cocoa (*Theobroma cacau.* L) Yield and Its Components*

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Two cocoa trials involving twenty-five progenies in Trial-1 and sixteen progenies in Trial 2, were grown under inland conditions in Peninsula Malaysia. Results of a factorial analysis with respect to yield for both trials over 1979–87, including yield components of bean weight, bean number and pod weight over four seasons between 1984–85 are presented. Yield, expressed as both pod production per tree and kg dry bean (kdb) production per ha, showed significant differences among progenies for both trials. However seasonal influence seemed more pronounced than progeny effect for pod production for both trials. The reverse was the case for kdb production per ha. Progeny x seasonal interaction was non-significant for both trials and for both yield expressions. Heritability (h^2w) was 93 per cent for pod production and 88 per cent for kdb production for Trial 1. A factorial analysis of pod weight, bean weight and bean number were carried out for five random progenies from Trial 1, and five from Trial 2 where UIT 1 was the common female parent. For the first trial, significant differences were noted for bean weight and bean number while the second did not. Bean weight was significantly influenced by season but pod weight was not. Bean and pod weight showed no significant interaction with season. Heritability estimates (h^2w) was 5 per cent for pod weight, 94 per cent for bean weight and 55 per cent for bean number. Significant correlations for pod weight with bean weight and pod weight with bean number were obtained. Bean number with bean weight generally showed no correlation for the various progenies and individual genotypes analysed.

Cocoa yield in kg dry bean per tree can be broken down into various yield components *i.e.* [Yield (kg dry bean/tree) = Number of pods/tree x Average bean weight/pod x Bean No/pod.].

Actual pod production per tree varies considerably from season to season and from tree to tree (Toxopeus, 1969) and is governed by the number of flowers produced (Alvim, 1984; Young, 1986), percentage fruit set (Eskes, Beek & Toxopeus, 1977), the influence of cherelle wilt (Eskes *et al.*, 1977), and the effect of pest and disease on the developing pod until maturity.

The other yield components of average bean weight, bean number, and pod weight have been shown to have some level of relationship between them (Glendinning, 1963; Are & Atanda, 1972) and are also influenced by environmental factors (Are & Atanda, 1972). In this paper, data from two progeny trials are used for an analysis of yield and its components.

MATERIALS AND METHOD

Background of progeny trials

The two cocoa progeny trials (PT 1 and PT 2) were planted in Sg. Tekam,

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TABLE 1
LEAKAGE (%) OVER TIME IN RAINGUARDS TRIAL – ESTATE A, BANGI

Treatment	*Pretreatment*		*Treatment*	*Time after treatment* 3 months		6 months		9 months	
	Rainfall (mm)	*Leakage (%)*		*Rainfall (mm)*	*Leakage (%)*	*Rainfall (mm)*	*Leakage (%)*	*Rainfall (mm)*	*Leakage (%)*
AA Rainguards	Knapsack	6.1	F	35	3.8	30	6.5	Knapsack	10.6
RRIMGUD	Knapsack	7.8	E	35	12.4	30	18.8	Knapsack	24.4
Ebor eaves	Knapsack	4.5	B	35	5.0	30	6.8	Knapsack	7.7
			R						
			U						
			A						
			R						
			Y						
			SE ±		3.2		3.9		4.6
			LSD 5%		12.7		15.6		18.1

Total rainfall (Jan. - Dec. 1989) – 1775 mm
Number of raindays (Jan. – Dec. 1989) – 107

TABLE 2
PERCENTAGE LEAKAGE AND DAMAGED RAINGUARDS – ONE YEAR AFTER INSTALLATION – ESTATE A

Treatment		*Leakage (%)*	*Damaged rainguards (%)*
AA Rainguards		16.9	7.4
RRIMGUD		36.5	13.1
Ebor eaves		14.8	7.3
	SE ±	6.0	
	LSD 5%	23.9	

Note: All damaged rainguards also leaked

Pretreatment leakage. RRIMGUD suffered the highest incidence of leakage at 14.1 per cent due mainly to monkey damage. Initial leakages were very low in AA rainguards and Ebor eaves at about 1.0 per cent for both types of rainguards.

All damaged RRIMGUD were removed and replaced with fresh materials.

Post-treatment leakage. RRIMGUD showed the highest incidence of leakage at 34.0 per cent, three months after 'installation' and increased to 54 per cent, three months later. The leakage percentage in AA rainguards and Ebor eaves were generally similar upto six months after installation when they were around 14 per cent. At nine months after installation the leakage